AD-782 158

TACOS II DOCUMENTATION. VOLUME IIID. TERAIN, PMAP, SORTEV USER/PLANNER MANUAL

Braddock, Dunn and McDonald, Incorporated

Prepared for:

Army Missile Command

15 May 1974

DISTRIBUTED BY:

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5285 Port Royal Road, Springfield Va. 22151

AD-782158

BRADDOCK, DUNN AND McDONALD, INC.

1st Natl. Bank Bldg. E. Suite 1717
5301 Central Avenue, NE.
Albuquerque, New Mexico 87108
Phone (505) 266-5711

15 May 1974
BDM/A-16-74-R1
DAAH01-73-C-1150

TACOS II DOCUMENTATION

VOLUME IIID

TERAIN, PMAP, SORTEV USER/PLANNER MANUAL

Submitted to Headquarters, U.S. Army Missile Command, ATTN: AMSMI-DA, Redstone Arsenal, AL 35809.

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FOREWORD

This documentation effort was supported by the United States Army Missile Command under Contract No. DAAH01-73-C-1150, titled "TACOS II Model Documentation."

The documentation is a nine-part, three-volume report. Volume I is the EXECUTIVE SUMMARY, Volumes IIA, B, C, and D are the PROGRAMMER/ANALYST MANUALS for FRAG1, FRAG2, FRAG3, and TERAIN, PMAP and SØRTEV, respectively. Volumes IIIA, B, C, and D are the USER/PLANNER MANUALS for FRAG1, FRAG2, FRAG3, and TERAIN, PMAP and SØRTEV, respectively.

As an aid to the user, a somewhat different form of paragraph and page numbering scheme has been incorporated in this documentation. Each chapter title is the name of that portion of TACOS being discussed. There is one exception to this rule: the first chapter of each of Volumes II and III is a general overview of the TACOS operation. It is titled "Chapter TACOS." The headings within each chapter are of a modified numerical scheme. Except in a few places, the numbering is held to four levels. For each volume, the level designation and accompanying heading name typography is:

CHAPTER (ALL CAPS)

SECTION (ALL CAPS)

<u>Paragraph</u> (Initial Caps and Underline)

Subparagraph (Initial Caps)

TACOS.1.2.3.

Illustrations and figures are numbered consecutively within each section. The chapter and section number are an integral part of the numbering scheme (i.e., Figures FIA.1-1, FIA.1-2, etc.). Page numbering uses essentially the same scheme used for heading designations, however, only three levels are used. The level indicated in the page number corresponds to the major chapter division level on a page. An example would be:

F3C.1.2-1, 2, 3 ... n.

The user needs simply to locate the section of interest in the Table of Contents; he can then turn directly to the appropriate page. A variation on this methodology is used in the documentation for individual programs. The program name being documented or flowcharted is imbedded in the pagination scheme at the third level. In the documentation portion, pages are numbered consecutively with letters of the alphabet i.e.,

FIA.4.MAIN-A, B, C ...

In the flowchart portion, pages are numbered consecutively with numbers corresponding to the flowchart page i.e.,

FIA.4.MAIN-1, 2, 3 ...

This numbering scheme is somewhat nonstandard, but it is designed to afford the reader maximum ease of use.

Principal contributers to this work include: D. E. Edgemon, J. N. Gant, D. R. Jackson, J. S. Nowicki, J. J. Sikora, L. H. Skinner, and R. J. Upham. Project leadership was by R. L. Katz under the directorship of O. V. Fedoroff.

TERAIN, PMAP AND SØRTEV

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CHAPTER TACOS

TACOS II USER/PLANNER GUIDE

TACOS.1 TACOS II PROGRAM MODULES

TACOS II was originally created for IBM System/360 by members of the U.S. Army Combat Developments Command Air Defense Agency (USACDCADA) and Braddock, Dunn and McDonald Inc. (BDM). Its purpose is to simulate battles between ground based air defense systems and aerial weapons systems. This has been done to provide analysts and planners with an effective vehicle for rapidly measuring the relative effectiveness of air defense systems in tactical situations.

TACOS II was originally developed for use in direct support of the USACDCADA SAM-D Weapons Family Cost-Effectiveness Study (SAMWEPS). The major development cycle expended approximately 50 man-months over the period October 1966 to May 1967. Improvements and changes have been constantly made to TACOS II to encompass dynamic threat and defense concepts. The usefulness of TACOS II was enhanced when it was converted for use on a CDC 6600 by the U.S. Army Missile Command (MICOM) in 1971. It is this enhanced version which is described in this document.

The total simulation is composed of three major parts or FRAG's, each of which is one or more separate programs. These FRAG's are described in the following paragraphs.

TACOS.1.1 FRAG1 Description

FRAG1 simulates the air defense battlefield environment. This task is split into three parts. FRAG1A takes as input a digitized terrain file and a deployment of air defense sites to produce for each site a dominant mask function or DMF. A DMF describes the mask angle imposed by terrain on the site under consideration as a function of azimuth and range. FRAG1B utilizes input piecewise-linear penetrator attack paths and the digitized terrain file to produce detailed flight path data which may include the use of a terrain avoidance or following flight algorithm. FRAG1C, in turn, inputs DMF's and detailed flight paths from earlier parts

of FRAG1 along with a general description of the ECM environment to produce a file of environment events including terrain masking events, minimum ground clearance events, and burnthrough events.

TACOS.1.1.1. FRAG1A Function

The digitized terrain file used by both FRAG1A and FRAG1B is a reorganization of the results of an extensive manual map reading and recording project conducted by Stanford Research Institute. This file, recorded on a direct access storage device for rapid random access, is comparable to a map case containing several map sheets. Each sheet in this file is a 100 kilometer square and is composed of some marginal data and about 40,400 elevation data points. The elevation information is represented by row after row of spot elevations read to the nearest 10 meters. These spot elevations are taken at 500 meter intervals in a row; rows are spaced 500 meters apart, forming a grid. The digitized terrain file is drawn upon to collect the piece of terrain appropriate to each site input to FRAG1A.

Once the required terrain has been obtained, FRAG1A proceeds to calculate the dominant mask function for the site. The algorithm implemented here is an analog of manual terrain profiling to determine intervisibility with one major difference. Rather than simply determining a yes/no intervisibility judgment, the elevation angle to each visible ridgeline and the corresponding range are saved in a table marked off by azimuths. Site locations are specified in Universal Transverse Mercator (UTM) coordinates to eight digits (10 meter resolution). The altitude of the site may be input or computed by the program. The range of each system and system type (radar or optical) general information is also input to FRAG1A.

TACOS.1.1.2 FRAG1B Function

FRAG1B expects attack course descriptions (paths) and penetrator terrain following characteristics as input. These vehicle characteristics include a look-ahead range (which acts as a "smoothness" control on the path) and maximum and minimum maneuver limitations on the longitudinal plane of the vehicle. The attack course is specified as a

piecewise-linear approximation to the ground track of the aircraft. Velocity is constant on a given segment of the track and may change discontinuously at a track turn point. Altitude is generally specified as desired ground clearance although it may be specified as desired absolute altitude. Terrain following may be rejected to allow the vehicle to fly a piecewise-linear course between turn points in altitude. If terrain following is selected, the path control algorithm causes the vehicle motion to be approximated by arcs of circles with radii greater than those corresponding to the acceleration or g restrictions. The "aim point" of a particular maneuver is to clear the highest (in look elevation angle) peak within a prespecified "look-ahead" range by the desired clearance elevation. Samples of the vehicle path are taken each time the ground position of the vehicle crosses a 500 meter grid line. These samples are stored on the detailed flight path data set and serve to facilitate the generation of minimum clearance, burnthrough, and masking events by FRAGIC.

TACOS.1.1.3 FRAGIC Function

This final section of FRAGI merges data calculated in the two earlier sections with a specification of the ECM environment and system descriptions to produce minimum ground clearance events, terrain masking events, and burnthrough events. Each event includes a pair of times specifying the time of entry and time of exit from the indicated condition. Minimum ground clearance events are generated by determining all times of entry and exit of a path from the zone of input altitude above the ground. Terrain masking events are generated by determining times when the elevation angle of a threat vehicle, as measured from the given site, falls below the elevation angle given in the DMF for that site as well as times when the site-vehicle elevation angle rises above the appropriate dominant mask. Burnthrough or "ECM masking" events are generated by determining when the target range rises above the burnthrough range and when the target range falls below the burnthrough range. Other than DMF's and detailed flight paths, the inputs to FRAGIC include a list of sites for which environment events are desired, optional 100 point piecewise-linear

near-in mask angle functions for any or all sites, minimum system sensor frequency bands and corresponding ECM vulnerability constants, standoff jammer deployment, operating bands and power densities, self-screening jammer operating bands and power densities, and threat vehicle radar cross section as a function of off-boresight azimuth.

TACOS.1.2 FRAG2 Description

TACOS.1.2.1 General

The FRAG2 program module is the keystone of the TACOS model since this module calculates all events which are based on the geometry of threat-defense relationships and integrates these geometric events with environmental events calculated in FRAG1. This integrated event list then serves to drive FRAG3's dynamic engagement simulation module, FRAG3C. An appreciation of the FRAG2 functional relationship to the TACOS model may be gained by examining TACOS.3-1. As shown, FRAG2 is the sixth program module within the 10 module sequence of the TACOS model. FRAG2 uses a post-processor, the system utility SORT/MERGE program. Sequential execution of these two program modules converts raw air defense system characteristics, fire unit deployment data, threat attack data, and environmental events into a geometric and environmental event file for logical processing by FRAG3's dynamic war-game module, FRAG3C.

FRAG2 preschedules events which may be determined from considering the geometry and timing of the relationship between penetrator paths and deployed sites. Events generated by FRAG2 are sensor volume penetrations, radial velocity, tracking sensor angular rate and launcher angular rate limitations, fire volume penetrations, suppression attempts, threat priority changes, and ARM and decoy launches. Events generated by FRAG2 are integrated with environment events from FRAG1 and sorted into a sequential file.

TACOS.1.2.2 FRAG2 Function

Inputs to the event generation portion of FRAG2 include acquisition and tracking volume descriptions of IR or radar sensors, system pre-acquisition times, "vulnerable cylinder" radii for the suppression attempt model, missile flyout characteristics for the fire volume calculation, radial velocity, tracking sensor angular rate and launcher angular rate limitation threshold values, and threat geometric priority weights and transition ranges. Inputs relating to a specific battle situation include sites, paths, cells, and ARM or decoy launch points.

Processing in FRAG2 proceeds generally as follows. For each path-fire unit combination, all sensor volume penetrations are calculated. If the path is never unmasked while in any sensor volume or if the path never enters an acquisition volume, processing of this path-fire unit combination ceases and the next combination is examined. If the visibility criterion is met, then suppression attempts, limitations, fire volume penetrations, and priority transitions are calculated. Environment events are sorted as to relevance; those environmental limitations occurring outside of sensor volumes are discarded while relevant limitations are filed with other generated events.

Events generated in FRAG2 or passed through FRAG2 are identified by type, time of occurrence, fire unit affected, and path affected. As each event is outputted, the correspondence with a path is deleted and replaced with a correspondence with a cell. This amounts to generating several "cell" events from one "path" event, each new event being displaced in time by the corresponding cell's delay in starting down its path. Once all the expanded events are output, they are sorted into time sequence using the CDC supplied SORT/MERGE program.

Conceptually, the modeling for acquisition, path and fire volume penetrations, and limitations of the varieties mentioned are relatively simple. The modeling underlying the fire unit suppression attempt calculation and the priority transition calculation is not obvious, however. First consider the fire unit suppression attempt model.

Suppression attempt events are simply notations that the ground range from the fire unit to the target projection has fallen below a critical value, one of the vulnerable radii. The two radii correspond roughly to "active" and "passive" fire unit conditions. These tags, in turn, may correspond to "radiating"/"nonradiating" or "recently active"/ "inactive" dichotomies. Leaping ahead a bit in this discussion of FRAG's, the kill of fire unit is assessed in FRAG3 when the attacking penetrator vehicle reaches the crossing condition. At that point, the assumption is that appropriate bomb-type ordnance hits the fire unit and input ordnance P_k's take their toll.

The priority model in TACOS II is an extremely convenient and flexible tool for studying target choosing doctrines. In FRAG2, a geometric priority for a given target with respect to a given fire unit and its defended areas is calculated. The geometric priority varies as target position, velocity and aspect vary. In FRAG3, the geometric priorities of all targets in view of a given fire unit are immediately available any time that a reevaluation cycle occurs. The effective priority assigned to a given target in a reevaluation cycle is simply the geometric priority of that target as assigned in FRAG2 modified by such factors as status of engagement with this fire unit, status of engagement with other fire units, and remaining ammunition supply.

TACOS.I.3 FRAG3 Description

FRAG3 is composed of three parts or sections: FRAG3I, FRAG3C, and FRAG3R. The reading of input data from cards and the FRAG2 output file, and the sorting and storage of these data for use by FRAG3C is performed by FRAG3I. FRAG3C utilizes the FRAG2 event file to initiate and modify air defense engagements in the simulated battle. Engagement events are scheduled and outcomes are recorded to form the actual Monte Carlo game. FRAG3R is a postprocessor which utilizes FRAG3C history output to produce battle result reports and summaries.

TACOS.1.3.1 FRAG3I Function

The FRAG3I program module prepares input data for FRAG3's dynamic engagement simulation module, CADWAG. An appreciation of the FRAG3I functional relationship to the TACOS model may be gained by examining Figure TACOS.3-1. FRAG3I's preparation of input data is controlled by routine MAIN183 and performs the following functions:

TACOS.1.3.1.1 Reproduce a listing of the FRAG2 input systems characteristics, site deployment, and penetrator attack data via subroutine OUAPUT and the FRAG2 generated data set.

TACOS.1.3.1.2 Input FRAG3 required penetrator type, missile type, sensor type, site system type, and site system/penetrator type characteristics, via subroutine SYSIN1.

TACOS.1.3.1.3 Reproduce a listing of the data listed above (TACOS.1.3.1.2) via subroutine SYSOU1.

TACOS.1.3.1.4 Input, by card, the parameters necessary for operation of the detailed missile flyout model (MO28IN).

TACOS.1.3.1.5 Input the deployment and attack data from the FRAG2 generated data set and modify it with changes from the FRAG3 input data (TACOS.1.3.1.2) via subroutine INGRAB. Deployment data include site locations, and attack data, penetrator paths, and cell data.

TACOS.1.3.1.6 Input the type of air defense coordination that exists between the elements of the deployment via subroutine INGRAB.

TACOS.1.3.1.7 Data packing to provide optimum computer core utilization and minimize computer instruction requirements with respect to data access.

TACOS.1.3.1.8 Output all finalized, packed data, via subroutine OUSD, to be used by program CADWAG (FRAG3C).

TACOS.1.3.2 FRAG3C Function

FRAG3C is the section of the simulation which actually performs the engagement sequencing, Monte Carlo decisions, and history reporting. FRAG3C performs the simulation of the air defense engagements based on the geometric transitions and the environment transitions prescheduled by previous FRAGs.

An engagement in FRAG3C is initiated by either an unmask event, an acquisition volume penetration event, or by the threat reevaluation following some engagement, given that these first two types of events had already occurred. Engagements in FRAG3C are terminated either normally, by the assessment of the outcome of an intercept, i.e., a kill or a non-kill, or abnormally, when the priority of another target sufficiently exceeds the priority of the target presently under engagement to force breaking the present engagement and beginning an engagement on the new target, or by some limitation occurring during the engagement of the present target.

FRAG3C simulates large scale air penetration/air defense engagements by representing the operational activity of individual penetrators and elements of the defense as these interact with each other and the environment. The model, in a sense, does "battle bookkeeping" and assures that the activities of each battle element are self-consistent and are consistent with the activities of other battle elements.

Submodels in FRAG3C include a geometric priority scheme for determining engageability, command and control links, resource allocation, infrared and visual sensors, detailed radar volumes, intercept predictions, detailed missile flyout, single shot kill probability, radial velocity and tracking rate limitations, electronic countermeasures and deceptive jamming, and comprehensive debug capabilities.

TACOS.1.3.3 FRAG3R Function

FRAG3R is a post processor designed to summarize the results of a modeled battle simulated in FRAG3C. It utilizes the history data set to produce reports describing the effectiveness of the various air defense and penetrator systems described by the input to FRAG3C. There are 31 different types of reports which can be generated by FRAG3R. Production of the reports is controlled by logical variables which are input by the user.

The prime quantities reported in the FRAG3R summary are essentially the numbers of vehicles killed and the numbers of vehicles surviving. There are several other reports that are produced in the summary listing. These include accounts of what occurred to every missile for every fire unit averaged over the replications, and of the depth to which various threat cells penetrated into the defended area. In the summary describing the outcome of each engagement in the simulation, information which can easily be gleaned is the effect of terrain on the particular situation, the effect of system limitations such as radial velocity in a particular situation, the effect of overflying or bypassing defenses, and other comparable data.

TACOS.1.4 <u>TERAIN, PMAP, AND SØRTEV Description</u>

TERAIN, PMAP, and SØRTEV are not "FRAGs" of the TACOS II family (they might be called "fraglets"). However they are important enough to be included in a volume of their own. TERAIN and PMAP are preprocessors while SØRTEV is a postprocessor. TERAIN considers only the sites as they exist on terrain. It has the capability to produce, based on line-of-sight considerations, radar coverage diagrams. These help the user to determine the optimum location for a site. PMAP considers both site and path locations. It produces reports and printer maps which show the ability of these entities to engage. Thus, the user is aided in making the most effective use of his TACOS limited available resources. After a simulation has run through

FRAG3C, a question may arise about the operations of a particular site and/or path. SØRTEV allows a printout of the history events of any sites/paths, alone or in combination. Thus, it may be seen that while TACOS can be run without any of these peripheral processors, their use can significantly aid the user to complete a run and analysis in optimal time.

TACOS.1.4.1 TERAIN Function

TERAIN is a CDC 6600 computer program designed to illustrate pictorially and statistically the effects of the terrain surrounding an air defense site on that site's visibility coverage. Diagrams of actual terrain may also be produced. These TERAIN displays are used by the analyst for selection of weapon mix, air defense site locations and analysis of site/vehicle intervisibility.

TERAIN utilizes FRAG1A generated Dominant Mask Functions and terrain data to generate Critical Altitude Functions (CAFs). These CAFs specify the altitudes within engagement range above which a vehicle must climb for site/vehicle intervisibility to exist. Once a site CAF has been determined, it is possible, depending on the problem being analyzed, to pictorially display this information in many different forms.

Because of the variety of analysts and planners who use TERAIN for coverage diagram generation, TERAIN produces several types of diagrams which may be of special interest to different types of analysts and planners. For example, an air defense planner may wish to know when aircraft flying at specified terrain following altitudes will become visible, while an attack planner would like information concerning how to plan the vehicle paths to evade or effectively delay detection by a site. TERAIN, therefore, has been designed to display information for use by a wide range of analysts and planners.

TACOS.1.4.2 PMAP FUNCTION

PMAP is a CDC 6600 computer program used on a preliminary error detection and scenario development program for the TACOS II model. PMAP checks the scenario input cards for errors, checks for site/path engageability and provides a plot of the input scenario for analyst inspection.

Preliminary error detection provides a check for the following: identification of redundancies in site specifications, checking availability of terrain data for each site location and path leg endpoint, utilization of digitized terrain to evaluate site elevations, and identification of unusually long path legs.

To aid the analyst in scenario development, PMAP provides: a plot of the sites and paths on a Universal Transverse Mercator (UTM) grid, determinations of those sites which, due to their location, and engagement range, can engage penetrators on at least one path, along with a list of these paths, identification of targeted paths, and identification of those paths which end within engagement range of a site.

TACOS.1.4.3 SØRTEV Function

SØRTEV is a computer program forming part of the TACOS II model. It is a postprocessing program designed to select and reorder (sort) battle history events produced by the Monte Carlo simulation portion, FRAG3, and recorded in its output history data set. The printed battle history produced by FRAG3 represents occurrences in the simulated air defense battle on a totally time-ordered basis. SØRTEV was constructed to relieve analytical personnel of the tedium of extracting the battle history for a given air defense site or cell of air penetrators from the bulk of the histories of all other sites or cells.

TACOS.2 PROGRAM MODULE RELATIONSHIP TO THE TACOS SYSTEM

Previous sections have explained the overall workings of the FRAGs comprising the TACOS II model. Figure TACOS.2-1 shows the FRAGs' interrelationship. It can be seen that FRAG1 is primarily concerned with

A. MANIPULATE ENVIRONMENT
   1. DOMINANT MASK FUNCTIONS
   2. DETAILED FLIGHT PATHS
   3. GENERATE TERRAIN EVENTS
   4. GENERATE ECM EVENTS
   5. DETAILED SENSOR VOLUME PENETRATIONS
   6. SENSOR LIMITATIONS

B. PRESCHEDULE GEOMETRIC EVENTS
   1. SENSOR VOLUME PENETRATIONS
   2. SYSTEM LIMITATIONS
   3. FIRE VOLUME PENETRATIONS
   4. SUPPRESSION ATTEMPTS
   5. PENETRATOR PRIORITY CHANGES
   6. ARM AND DECOY LAUNCHES

C. INTEGRATE ENVIRONMENT EVENTS

D. TIME SORT EVENT FILE

E. SIMULATE AND REPORT RESULTS

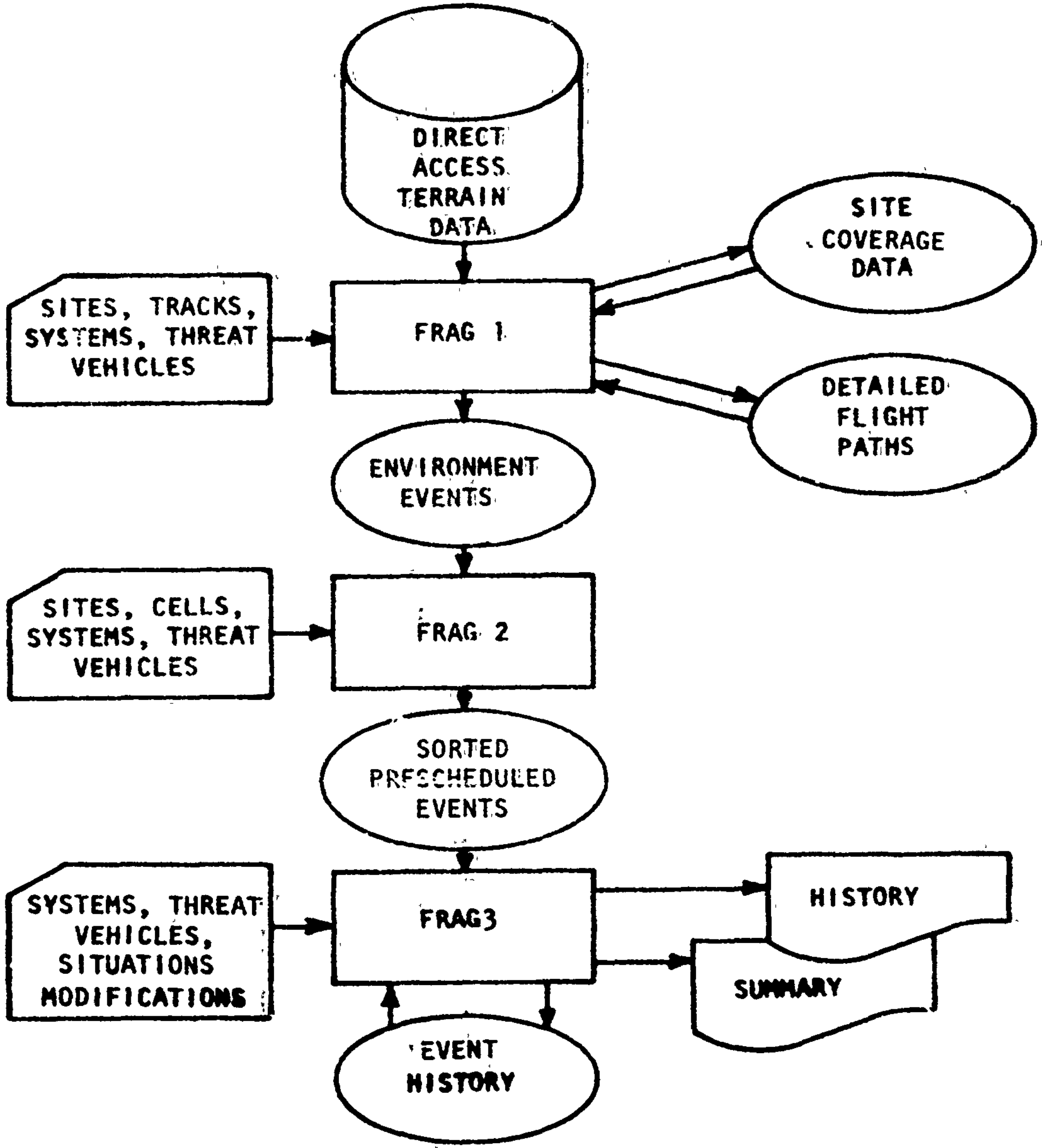


Figure TACOS.2-1. TACOS Functional Diagram

what might be called environmental events. FRAG2 determines crude game events while FRAG3 performs the Monte Carlo decisions and maintains the bookkeeping which determines the final outcome of the simulated air battle.

TACOS.3 DATA FLOW BETWEEN TACOS PROGRAM MODULES

Figure TACOS.3-1 shows the data flow between TACOS FRAGs and fraglets. In the upper left-hand corner of each major "box" is a number which indicates the sequence in which the modules are run. Note that PMAP, TERAIN, and SØRTEV are not essential to the complete successful run of a TACOS simulation. However, the information gleaned from PMAP and TERAIN output, intelligently applied to FRAG1 inputs, can significantly increase the probability of a successful run. Even all the care of experienced TACOS users/analysts can occasionally result in erroneous output. SØRTEV can be used to isolate the problem, not only to a particular site/cell combination, but to a particular time in the site/cell's engagement process.

TACOS.4 TIME BUDGET

TACOS.4.1 Introduction

In order to establish a true perspective of time budgets in the application of the TACOS model, it is necessary to achieve understanding as to the type application required. Defining particular type applications is a most difficult task due to the versatile nature of the model. The TACOS model was specifically designed to accommodate a wide spectrum of air defense studies. This requires a capability to simulate air defense weapon systems, different forms of threat, and characteristic environments. The model must accurately portray any scenario designed to resolve air defense problem areas. The air defense problem areas that have been successfully investigated with TACOS include design of air defenses, development of air defense force levels, development of employment

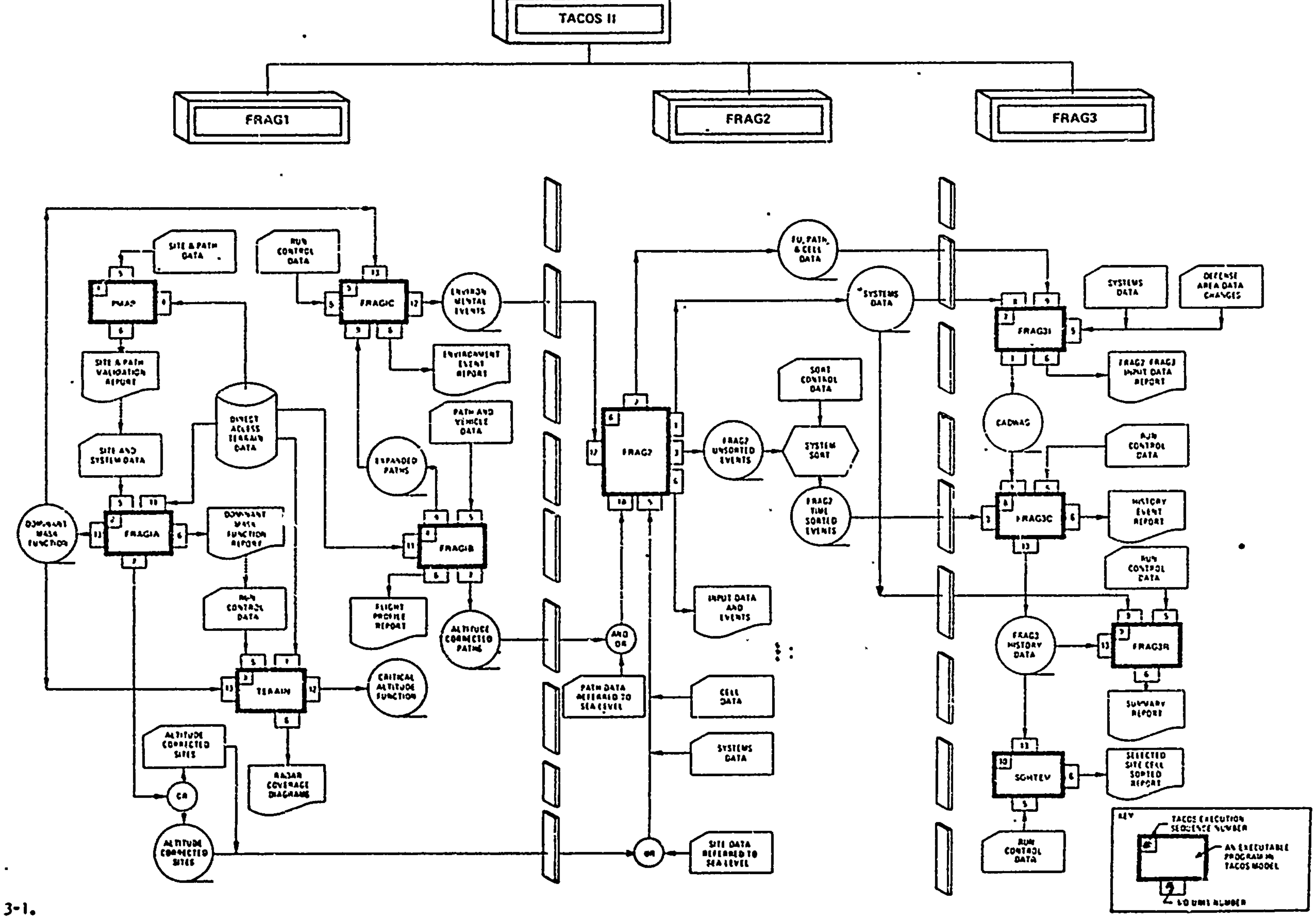


Figure TACOS 3-1.
Data Flow Diagram

doctrine and firing doctrine, evaluation of new weapon concepts and improvement concepts for existing systems, determination of the effects of electronic and infrared countermeasures, the evaluation of command and control systems, and the determination of ammunition requirements. The particular type application may require definition of a simple point type defense; or the definition of a full complement of systems forming an overall field army defense. The point type defense may have only one or two systems defined and token quantities of deployed sites and penetrator paths whereas, the field army defense may approach the maximum limitations of the model.

TACOS.4.2 <u>Structure Planning</u>

A TACOS simulation is not a straightforward FRAG1, FRAG2, FRAG3 progression of design points. The early FRAG's of any simulation generally combine many separate portions of scenarios that are later filtered to form specific FRAG3 simulations. Filtering may occur at the end point FRAG3's or at earlier FRAG's depending on limitations of various inputs. An example of this type early combining and subsequent filtering pertains to site selections. All sites may be included in a common FIA. In the progressive FIC step, the sites may be in one common FIC or split into a number of FIC's. The same relationship applies to the subsequent F2 step. Unwanted sites, systems, paths, or cells may be, in effect, discarded in FRAG3 to form the desired scenario. This example of dendritic (tree) structure is advised for economy of time and money. Formation of common FRAG's is not limited to individual site groups, but may be extended to system types, paths, cells, etc. The model has additional features to permit a series of FRAG3's based on common FRAG2's This may be in the form of differing system or threat input in FRAG3 or through the setting of a series of ON/OFF type switches. System data input changes may pertain to system characteristics that include reaction times, firing doctrines, and kill probabilities. Threat changes may include

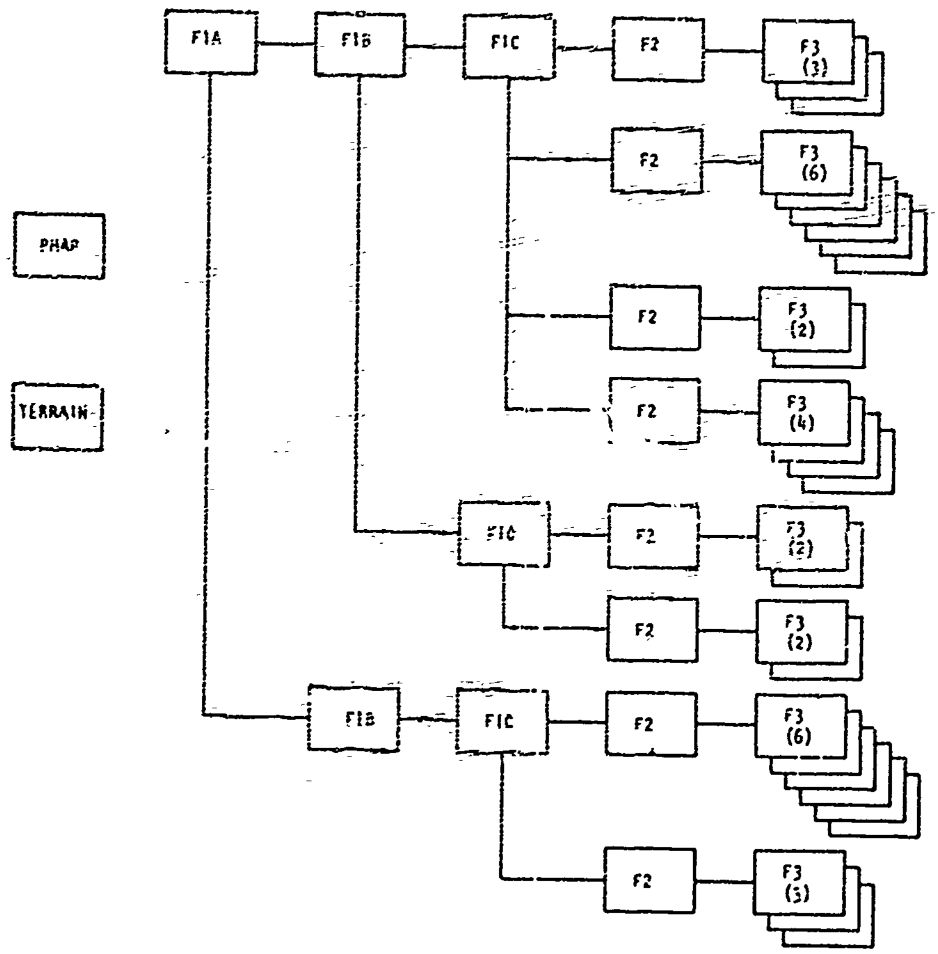
dropable ordnance quantity, cell object density, air-to-ground kill probability, and specialized function indicator changes. ON/OFF type switch settings may include site suppression, operability, terrain environment, and ECM. An example from an actual study illustrating dendritic structure is presented in Figure TACOS.4-1. In this particular study, 28 separate F3s were produced from eight F2s, three F1Cs, two F1Bs and one F1A.

Medium scope time estimates as a percentage of total for a PMAP/TERAIN (P/T), F1A, F1B, F1C, F2, and F3 TACOS model family were tabulated by initial activity, and type study to show relative weight of each member by category. Initial and subsequent hours were applied to member programs forming a study structure as presented in Figure TACOS.4-1. Total hours for each level, total hours, and percentages of total are presented in the same figure. Table TACOS.4-1 presents the tabulated comparisons, as percentages of overall activity, which are summarized below:

WEIGHT	INITIAL ACTIVITY	SUBSEQUENT ACTIVITY	TYPE STUDY
Maximum	F3	F1B	F3
	F1B	F1C	F2
	F2,F1C	F2	F1B,F1C
Minimum	F1A,P/T	F1A,P/T,F3	P/T,F1A

TACOS.4.3 User Experience

It is difficult to assess time requirement estimates without some consideration to the involved personnel. Model versatility by necessity demands extensive inputs accurately keyed to real life systems and environments. Normal experience in TACOS results in personnel being specialized in certain fields or portions of the model. The area of specialization may be in air defense systems inputs, site deployments; or threat



							TOTAL
HOURS	35.550	17.000	164.875	161.750	309.450	427.250	1115.875
%	3.19	1.52	14.78	14.50	27.73	38.29	100.00

Figure TACOS.4-1. Typical TACOS Dendritic Structure

inputs. Further classification may include specialization in one or more TACOS FRAGs or related PMAP, TERAIN or SABTAAD[1] programs. In studies of any appreciable size, the quality of collective personnel experience has a most decided impact on: (1) the time required to complete and (2) the quality and scope of the finished product.

TABLE TACOS.4-1

PERCENTAGE COMPARISONS OF OVERALL ACTIVITY

	Initial Activity	Subsequent Activity	Type Study
PMAP/TERAIN (P/T)	3.15	4.73	3.19
F1A	3.81	5.67	1.52
F1B	19.65	40.58	14.78
F1C	13.67	26.47	14.50
F2	15.39	18.08	27.73
F3	44.33	4.47	38.29

[1] SABTAAD is a path generating computer program designed by members of the USAADS.

TACOS.4.4 User/Experience Survey

TACOS.4.4.1 Time Budget Estimates

In order to aid the user in the application of TACOS to representative air defense problems, time budgets have been prepared for each of the major components (or FRAG's) of TACOS. The time budgets are presented in tabular form in Tables TACOS.4-2 through TACOS.4-9.

The data in the tables were gleaned from a survey of experienced TACOS users in the air defense community. The Delphi technique was used to obtain the statistical averages presented.

The time estimates included in the tables are of a generalized nature. The particular designs of TACOS scenarios may vary considerably from the time estimates presented. A scenario without an ECM requirement, for example, would not require ECM or sensor definition in FIC but would require additional sensor definition in F2. This would result in appreciably reduced preparation time for FIC and an increased preparation time for F2. Drastic time variance from presented figures may be expected with reference to subsequent data preparation. Subsequent FIB's may be due to redesigned attack (long time estimate) or a simple penetrator input data definition change (short time estimate). Subsequent FIC's may be due to addition of new system and defining ECM characteristics (long time estimate) or to a new attack FIB input (short time estimate). Similar relationships may be cited for the other programs. Therefore, any application of time estimations should be given careful consideration by experienced TACOS personnel.

The data in the tables are presented in three major columns. In the first column, the time (in hours) derived from the Delphi survey is presented broken out in two analysis areas and their sum. As an aid to estimating relative difficulty between tasks and scopes, the second column presents the hourly data normalized by the total time for a medium size study. Finally, the last column block presents the ratio of Subsequent hours to Initial hours. This can serve as a planning aid to estimate Subsequent Activity when Initial Activity is known.

TABLE TACOS.4-2
TIME BUDGET (FRAGIA)

INITIAL ACTIVITY (IA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	26.333	4.750	31.083	1.549	0.279	1.828
MEDIUM	13.583	3.417	17.000	0.799	0.201	1.000
SMALL	7.375	1.000	8.375	0.434	0.059	0.493

RATIO OF SA/IA

SCOPE	a	b	c
LARGE	0.547	0 649	0.563
MEDIUM	0.693	0.402	0.635
SMALL	0.729	0.500	0.702

SUBSEQUENT ACTIVITY (SA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	14.417	3.083	17.500	1.336	0.286	1.622
MEDIUM	9.417	1.375	10.792	0.873	0.127	1.000
SMALL	5.375	0.500	5.875	0.498	0.046	0.544

a - DATA PREP AND CHECKOUT
b - INTERPRETATION AND ANALYSIS OF RESULTS
c - TOTAL TIME (a+b)

TABLE TACOS.4-3
TIME BUDGET (FRAG1B)

INITIAL ACTIVITY (IA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	403.000	1.125	404.125	4.597	0.013	4.610
MEDIUM	85.917	1.750	87.667	0.980	0.020	1.000
SMALL	10.750	0.500	11.250	0.123	0.006	0.128

RATIO OF SA/IA

SCOPE	a	b	c
LARGE	0.430	1.000	0.432
MEDIUM	0.886	0.619	0.881
SMALL	0.791	1.000	0.800

SUBSEQUENT ACTIVITY (SA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	173.417	1.125	174.542	2.246	0.015	2.261
MEDIUM	76.125	1.083	77.208	0.986	0.014	1.000
SMALL	8.500	0.500	9.000	0.110	0.006	0.117

a - DATA PREP AND CHECKOUT

b - INTERPRETATION AND ANALYSIS OF RESULTS

c - TOTAL TIME (a+b)

TABLE TACOS.4-5
TIME BUDGET (FRAGIC)

INITIAL ACTIVITY (IA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	66.250	5.000	71.250	1.086	0.082	1.168
MEDIUM	58.250	2.750	61.000	0.955	0.045	1.000
SMALL	40.125	2.125	42.250	0.658	0.035	0.633

RATIO OF SA/IA

SCOPE	a	b	c
LARGE	0.819	0.625	0.803
MEDIUM	0.820	0.955	0.826
SMALL	0.875	0.529	0.858

SUBSEQUENT ACTIVITY (SA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	54.250	3.125	57.375	1.077	0.062	1.139
MEDIUM	47.750	2.625	50.375	0.948	0.052	1.000
SMALL	35.125	1.125	36.250	0.697	0.022	0.720

a - DATA PREP AND CHECKOUT

b - INTERPRETATION AND ANALYSIS OF RESULTS

c - TOTAL TIME (a+b)

TABLE TACOS.4-6
TIME BUDGET (TERAIN)

INITIAL ACTIVITY (IA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	5.000	7.500	12.500	0.552	0.83	1.381
MEDIUM	3.800	5.250	9.050	0.420	0.580	1.000
SMALL	1.000	1.750	2.750	0.110	0.193	0.304

RATIO OF SA/IA

SCOPE	a	b	c
LARGE	0.975	0.817	0.880
MEDIUM	0.592	0.619	0.608
SMALL	0.500	0.786	0.682

SUBSEQUENT ACTIVITY (SA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM a	NORMALIZED TO C (MEDIUM b	NORMALIZED TO C (MEDIUM c
LARGE	4.875	6.125	11.000	0.886	1.114	2.000
MEDIUM	2.250	3.250	5.500	0.409	0.591	1.000
SMALL	0.500	1.375	1.875	0.091	0.25	0.341

a - DATA PREP AND CHECKOUT

b - INTERPRETATION AND ANALYSIS OF RESULTS

c - TOTAL TIME (a+b)

TABLE TACOS.4-7
TIME BUDGET (PMAP)

INITIAL ACTIVITY (IA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	3.125	11.375	14.500	0.625	2.275	2.900
MEDIUM	1.250	3.750	5.000	0.250	0.750	1.000
SMALL	0.415	3.250	3.665	0.083	0.650	0.733

RATIO OF SA/IA

SCOPE	a	b	c
LARGE	0.966	0.670	0.734
MEDIUM	1.04	0.587	0.700
SMALL	0.602	0.577	0.580

SUBSEQUENT ACTIVITY (SA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	3.020	7.625	10.645	0.863	2.179	3.041
MEDIUM	1.300	2.200	3.500	0.371	0.629	1.000
SMALL	0.250	1.875	2.125	0.071	0.536	0.607

a - DATA PREP AND CHECKOUT

b - INTERPRETATION AND ANALYSIS OF RESULTS

c - TOTAL TIME (a+b)

TABLE TACOS 4-8
TIME BUDGET (FRAG2)

INITIAL ACTIVITY (IA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	151.500	8.167	159.667	2.207	0.119	2.326
MEDIUM	63.500	5.150	68.650	0.925	0.075	1.000
SMALL	23.333	5.083	28.417	0.340	0.074	0.414

RATIO OF SA/IA

SCOPE	a	b	c
LARGE	0.645	0.276	0.626
MEDIUM	0.515	0.330	0.501
SMALL	0.507	0.246	0.460

SUBSEQUENT ACTIVITY (SA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	97.750	2.250	100.000	2.842	0.065	2.907
MEDIUM	32.700	1.700	34.400	0.951	0.049	1.000
SMALL	11.833	1.250	13.083	0.344	0.036	0.380

a - DATA PREP AND CHECKOUT

b - INTERPRETATION AND ANALYSIS OF RESULTS

c - TOTAL TIME (a+b)

TABLE TACOS 4-9
TIME BUDGET (FRAG3)

INITIAL ACTIVITY (IA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	323.333	23.667	347.000	1.635	0.120	1.755
MEDIUM	177.750	20.000	197.750	0.899	0.101	1.000
SMALL	87.500	12.667	100.167	0.442	0.064	0.507

RATIO OF SA/IA

SCOPE	a	b	c
LARGE	0.036	0.174	0.045
MEDIUM	0.036	0.106	0.043
SMALL	0.047	0.049	0.047

SUBSEQUENT ACTIVITY (SA)

SCOPE	HOURS a	HOURS b	HOURS c	NORMALIZED TO C (MEDIUM) a	NORMALIZED TO C (MEDIUM) b	NORMALIZED TO C (MEDIUM) c
LARGE	11.563	4.125	15.688	1.360	0.485	1.846
MEDIUM	6.375	2.125	8.500	0.750	0.250	1.000
SMALL	4.125	0.625	4.750	0.485	0.074	0.559

a - DATA PREP AND CHECKOUT
b - INTERPRETATION AND ANALYSIS OF RESULTS
c - TOTAL TIME (a+b)

In the tables, Initial Activity refers to that period of data acquisition, preparation, formatting, and debugging for the initial runs of TACOS. Subsequent Activity refers to the period when production runs of TACOS are made. Scope refers to the size of the air defense battle being simulated. A "small" scope may be interpreted to be approximately a dozen sites and penetrator vehicle paths. A "medium" scope would be about 100 sites and paths. A "large" scope would be exercising TACOS to its limits of 255 sites and paths.

TACOS.4.4.2 Time Comparisons

Data preparation and check-out (a) prior to the execution of production runs takes considerably more time than data interpretation and analysis, (b) the ratio between a and b in Table TACOS.4-10 is indicated to be approximately 9:1. PMAP, TERAIN, and FIB with SABTAAD are three exceptions with a reverse trend at an approximate 4:6 ratio. This is presumably correct since PMAP and TERAIN are primarily data preparation/check-out programs, and FIB with SABTAAD inputs are primarily accomplished by SABTAAD. This relationship for the medium scope case is presented in Table TACOS.4-10.

TACOS.5 USER NOTES

TACOS.5.1 Scenario Generation

Scenario generation involves describing the overall game situation to be portrayed in the TACOS simulation effort. Before the scenario can be developed, it is essential to achieve thorough definition and understanding of the problem(s) undergoing investigation. The problem(s) may pertain to ground system characteristics, organization, and operational tactics and doctrine. System characteristics may include comparisons of candidate systems, demonstrations of individual system capabilities and compatibilities with other systems, evaluations of new weapon concepts and modification improvements to existing systems, and determinations of ammunition load

TABLE TACOS.4-10
TIME COMPARISONS

	Initial Activity		Subsequent Activity	
	a	b	a	b
F1A	.80	.20	.87	.13
SABTAAD	.88	.12	.77	.23
F1B w/o SABTAAD	.98	.02	.99	.01
F1C	.95	.05	.95	.05
QRSG	.90	.10	.86	.14
F2	.92	.08	.95	.05
F3	.90	.10	.75	.25
PMAP	.25	.75	.37	.63
TERRAIN	.42	.58	.41	.59
F1B w SABTAAD	.44	.56	.59	.41

a → Data preparation and check-out

b → Data interpretation and analysis

requirements. Organizational problems relate from small unit to overall complex structures. This may range from the structure of a HAWK battery to the numbers and types of complementing systems forming a field army defense. Problems in air defense design are resolved through evaluation of weapon family mix and force levels. Tactics and doctrine problems may include the methods and procedures of identification; rules of engagement; firing techniques; electronic and infrared countermeasures and counter-countermeasures; and deployment requirements and techniques. Command, control (or coordination), and communication networks and procedures may be considered within this category.

The problem(s) may also pertain to penetrator vehicle type characteristics, tactics, and doctrine. Penetrator vehicle type characteristics may include comparison of different vehicle types; determination of ordnance load and ECM or other penetration aid loads; and determination of requirements for new weapons concepts. Tactics and doctrine problems include determination of optimum attack tactics against various types of ground air defense systems or ground targets defended by various air defense systems; and the number, type, and timing of releasing various types of ordnance and air-ground missiles.

The nature of the problem undergoing investigation will dictate the character and scope of the scenario. To demonstrate individual system characteristics such as rates of fire, detection ranges, or various reaction times, it may suffice to simulate only that system in a solitary point defense and subjected to a variety of attacks. However, families of systems deployed in various roles of defense may be required to evaluate force level requirements. The problem may require a scenario characterized for a specific time frame, terrain conditions, or weather environment.

In addition to understanding of the problem, knowledge of the TACOS model capabilities will ensure generation of a scenario that can be accurately simulated by TACOS.

TACOS.5.2 Ground Systems

TACOS.5.2.1 Requirements

Ground systems data generally represent the bulk of data required as input into the TACOS model. Discussion here will pertain only to the system identifier. Each ground air defense system type input to TACOS will have a unique identifier consisting of four alphanumeric characters. The maximum number of systems allowed is 15.

TACOS.5.2.2 Source

Participating systems to be defined are presented in the study scenario.

TACOS.5.2.3 Procedures

The identifiers selected for each ground system type may be such that they are readily associated to the particular systems. This permits ready system identification when analysts must study volumes of simulation event listings and summary results. HERC, HAWK, REDI, and VULC identifiers readily identify the NIKE HERCULES, HAWK, REDEYE, and VULCAN air defense systems, respectively. This technique may be expanded to provide additional system descriptors such as the following:

- IHWK → Improved HAWK
- BHWK → Basic HAWK
- HKSP → Self Propelled HAWK
- HKTW → Towed HAWK
- T57T → ZSU-57-2 (twin) Towed
- SP23 → ZSU-23-4 SP

It may be useful in certain cases to define the same system type with different identifiers. This may be done to permit differences in operational doctrines that may occur dependent upon assigned responsibility. An example being CHAPARRAL assigned to protect an airbase and also used in defense of a division. The identifiers again may be descriptive, relating to the system and assignment, e.g., CHAB → CHAPARRAL Airbase and CHDV → CHAPARRAL Divisional. Another reason to use different identifiers for the same system

type (the systems characteristics may be identical) pertains to statistical reporting of data by systems type in RECAP. For example, if CHAPARRAL is used in airbase and division defense, it may be advantageous to have statistical data for each defensive role.

TACOS.5.3 Sites

TACOS.5.3.1 Requirements

All sites input into TACOS must have a unique four character alphanumeric identifier; be linked to an inputted system type; and geographically located through specification of UTM coordinates. If altitude above sea level is not specified, the terrain altitude at that location plus the height of the antenna (or observation point) above terrain, will be used automatically. Azimuth sectors of coverage may be input for individual sites if required. The maximum number of sites allowed is 255.

TACOS.5.3.2 Source

Data pertaining to sites is obtained from the study scenario map overlays, applicable systems documentation, and PMAP outputs.

TACOS.5.3.3 Procedure

TACOS.5.3.3.1 Identifiers

The site identifier may be coded to facilitate crossreferencing; correlation to deployed area (Division, Corps, etc.), defended asset (Airbase, Communication Center, etc.), or membership in command network (Group, Brigade, etc.); provide security screening; permit ease of recognition during subsequent analysis of event histories; and denote each specific site through sequence numbering. The first character of the four character

identifier should be alphabetic to ensure compatibility with an associated program TERAIN. Examples of this type of coding follow:

		HC12
System	HAWK	
Area	CORPS	
Sequence #	Site 12	
		CB06
System	CHAPARRAL	
Airbase	BITBURG	
Sequence #	Site 06	

TACOS.5.3.3.2 Map Overlay

The ground force planner has two responsibilities: (1) deploying the ground assets to maximize his effectiveness for offense, and (2) minimize the effects of penetrator tactics that may be employed against the defense. Large scale situations are normally presented upon 1:250,000 map overlays. Ground organizational boundaries, defended assets, and defending units are plotted accurately on this overlay. Site sectors of fire or responsibility, and C^2 networks may be indicated. Smaller scale situations are normally presented upon 1:50,000 map overlays. The individual site UTM coordinates, altitudes, and azimuth sectors are then obtained from the map overlay.

TACOS.5.3.3.3 Verification

A most important procedure involves the verification of site data prior to execution of FRAGIA. Site identifiers and their respective UTM coordinates are obtained from the map overlay and transcribed onto coding sheets in a particular format. The coding sheets are then read by a keypunch operator to produce a deck of site cards. This process of reading coordinates,

transcribing, and keypunching pertaining to hundreds of sites is tedious and introduces error easily. Some common errors introduced are:

- Improper site coordinate
- Duplicate site names
- Duplicate site coordinates
- Incorrect site altitude

To reduce errors, the site cards are input into a special program 'PMAP' for site processing and error checking. PMAP detects errors and presents messages relating to:

- Improper structure of UTM coordinates
- Sites having the same identifier but different coordinates
- Duplicate site cards
- Different sites having the same coordinate
- Site altitude being less than that same point on the terrain map
- Site location not on the selected terrain map.

PMAP also forms a UTM grid map to selectable scale and plots all site locations. Based upon known character of deployment, or physically comparing this grid map deployment to the map overlay deployments, site deployment errors are observed readily and corrected accordingly.

TACOS.5.3.3.4 Total Sites

The maximum allowable limit of 255 sites is often exceeded upon full deployment of all air defense fire units in the total tactical area. Two techniques may be used separately or jointly to reduce the total number of sites within the established limitation. Once the game track paths are established, all sites are screened for capability of engaging a cell on that path. Any site unable to engage any paths may be discarded. One part of the PMAP program checks site/path engageability. Inputs required are the

established track paths, the site locations, and each system's engageable range of interest. PMAP engageability processing will produce the following:

- Lists input data such as system identifiers and associated engageability range of interest.
- Prepares a table by system site identifier of the paths that penetrate each site's range of interest or an indication that the site cannot engage any cells on these paths.

If the PMAP engageability function is unable to reduce the total number of sites satisfactorily, probability of operability factors could further reduce the total. However, applying probability at this early state has a disadvantage of having the same sites inoperable for all FRAG3 replications. This may provide misleading results; effectively, similar to results from faulty deployment. Normally, assessment of probability is done before each FRAG3 replication and results in different combinations of inoperable sites for each respective replication.

TACOS.5.4 Paths

TACOS.5.4.1 Requirements

All track paths input into TACOS must have a unique five digit integer identifier, be linked to an input penetrator type, and geographically defined through specification of UTM coordinates for a series of path points along the track path. Path point definition will include altitude, velocity, and a number of specialized function indicators. These indicators pertain to maneuver codes and modes, attrition and short RECAP's, flare drop mode, high altitude mode, and no fire zones. The maximum number of paths allowable is 255, and the maximum number of points permitted per path is 255.

TACOS.5.4.2 Source

Data pertaining to paths are obtained from the study scenario/attack plan, map overlays, penetrator documentation, intelligence summaries, and PMAP output.

TACOS.5.4.3 Procedures

TACOS.5.4.3.1 Attack Plan

The attack plan is the basic document used in preparation of the track paths forming an attack model. It is normally prepared by a committee of selected representatives from Air Force, Army, and intelligence agencies. In developing a realistic plan, the committee of air attack planners must consider carefully such factors as aircraft inventories, aircraft characteristics, weather conditions, hardness of targets, ordnance capabilities, and the effectiveness of the ground force defense. The completed attack plan will contain information on ground targets to be attacked, numbers and type aircraft allocated per ground target type, ordnance loads, attack phasing and timing, and penetration aid techniques. It also will specify aircraft ingress and egress profiles in terms of altitudes and velocities. The attack profile (Figure TACOS.5-1) will be depicted in terms of aircraft maneuver tactics (climb, dive, level, turn, etc.), altitude, velocity, and a reference distance from the target, e.g.

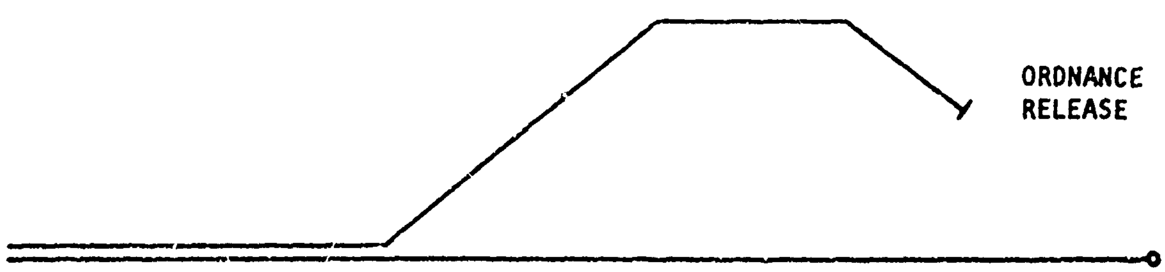


Figure TACOS.5-1. Typical Flight Profile

Approach target at 480 knots (250 m/s), 200 feet (60 m) altitude. At 10 km from target start pull up, obtain 8200 feet (2500 m) altitude at 6 km from target. Continue flying at 480 knots (250 m/s), 8200 feet (2500 m) altitude until 4 km from target. Dive toward target. At 4900 feet (1500 m) altitude and 2 km from target, release ordnance. Turn and dive at 640 knots (335 m/s) to 200 feet (60 m) altitude and exit.

TACOS.5.4.3.2 Map Overlay

The air force planner will prepare a map overlay showing ground organizational boundaries, the FEBA, precise ground deployment of the known larger type AD systems, and all other ground targets listed in the attack plan. Smaller AD systems, not subject to attack, may be represented by their higher echelon symbology in the general area of deployment. The air force planner must be aware of any "known site" deployment changes made by ground planners.

TACOS.5.4.3.3 Path Development

An initial step in track path development is to study the attack plan and categorize the various functional path groups. This may include types of air defense suppression, reconnaissance flights, airbase attack and various other forms of ground target attack. Each particular group may have further definition or direction that will have bearing on establishing the track paths. Air defense suppression, as an example, may require progressive forward to rear ('roll-up') site suppression developing a corridor for low altitude penetration to army rear airbases.

Study of the ground force deployment overlay on a terrain map will assist in assessing avenues of approach. If corridor-busting is planned, locating the corridor will be done along with determining avenues of approach. The attack plan will indicate the total number of target sites, enemy knowledge of location as a percentage of the total, and the number that should be attacked. Based on this information, the specific targets are selected. The next procedure involves tracing each particular track path on a map overlay. One or more map overlays are used for each type attack, or for each functional path group. This is done for ease of visualizing the type attacks and the subsequent reading of the many path point coordinates.

The track paths are then defined through locating a series of points along the path. A path point is required for any change in course direction, velocity, or altitude; or to turn ON/OFF some specialized

function indicator at a desired location. One example of a specialized function is to establish a check point at the bomb release track point. This allows RECAP statistics to reference the number of aircraft killed prior to that point on that path.

TACOS.5.4.3.4 Path Data

Path data is input to TACOS via Path and Point card types. Path card data has a unique integer identifier for each track path, names the penetrator vehicle associated with this track path, and specifies the number of path points defining this track path. A point card type is used for each point located on the track path. Path point data includes UTM coordinates of the point, an altitude, velocity (pertains to velocity of the penetrator on the segment preceding this point), and a number of specialized function indicators (maneuver codes, maneuver modes, attrition RECAP, short RECAP, flare drop zone, high altitude mode, and no fire zone). Path point cards are sequentially ordered and numbered from the origin to the termination of the track path.

TACOS.5.4.3.5 Path Identifiers

Path identifiers are limited to integers from 1 to 65535. Study of the attack plan and selective assignment of path identifiers may provide ease of subsequent analytical efforts. Simple designated blocks of numbers may be assigned to various functions, e.g.

- 00001 - 00050 SAM-D attacks
- 00051 - 00100 CHAPARRAL attacker
- 02001 - 02020 AIRBASE attacker
- 02021 - 02030 AIRBASE attacker escort
- 02081 - 02100 Reconnaissance Flights

The five digit identifier, however, permits more extensive descriptive coding. Path identifier coding may reference the type attack/mission, target system type or specific target, time phase of the attack, penetrator

characteristic or overall track profile, and cross-reference to a related track. Type attack/mission coding may pertain to air defense suppression, ground target attack, corridor-busting, division close support, airbase attacker, bomber escort, and reconnaissance. Target system type may define the particular target system and/or site such as SAM-D/Site 01, airbase/ BITBURG, LANCE/Site 41, and Command Center/2nd Division. Time phase indication within the path identifiers may pertain to a time phased Division, Corps, Army air defense suppression attack preceding a deep penetration bomber attack. Penetrator characteristic descriptors may include discrimination by class of penetrator (heavy bomber, fighter bomber, standoff tactical weapon carrier, or standoff weapon when input as penetrator), or specific penetrator types (Tu-22 Blinder, Su-11 Flagon A, F-106A Delta Dart, A-4F Skyhawk, AGM-78 Standard ARM, etc.). Path profile coding may have reference to altitude profile discrimination such as hi-lo-hi, lo-lo-lo, etc. Cross-reference codes may be established between paths or groups of paths that are related such as bomber paths and their respective escorts' paths or the ARM carrier paths and their respective ARM paths. The comprehensiveness of path identifier coding depends upon the scope of the study and the ingenuity of the attack planner. An abbreviated example of path coding is shown below:

- Type Mission
  1. Air defense
  2. Airbase
  3. Ground Target
  4. Escort
  5. Reconnaissance
- Attack Phase
  1. Corridor-busting
  2. Airbase attack
  3. Army/Corps select target groups
  4. Other target groups

System/Target attacked

	AD Systems		AIRBASES		Ground Targets
1.	HERCULES	1.	BITBURG	1.	LANCE
2.	HAWK	2.	RAMSTEIN	2.	PERSHING
3.	HAWK SP	3.	SPANGDAHLEM	3.	Command Centers
4.	CHAPARRAL	4.	- - - -	4.	Communication Centers
5.	- - - -	5.	- - - -	5.	POL Depots

Site Sequence Code

Reference to target array

TRACK 1 1 2 6 0

Mission——Air Defense suppression
Phase——Corridor busting
System——HAWK
Site——#60

TRACK 1 3 1 0 2

Mission——Air defense suppression
Phase——Army target group
System——HERCULES
Site——#02

TRACK 2 2 1 0 0

Mission——Airbase
Phase——Airbase
Target——BITBURG
Site——None

TRACK 4 2 1 0 0

Mission——Escort
Phase——Airbase
Target——BITBURG
Site——None

(Note ease of cross-reference to escorted track 22100.)

TACOS.5.4.3.6 Verification

A most important procedure involves the verification of path data prior to execution of FRAG1B. Reading of Map UTM coordinates for each path point, transcribing data into coding sheets in a particular format, and keypunching the vast quantity of path and point data is tedious and introduces error easily. Some common errors introduced are:

- Improper path point coordinates.
- Improper point sequencing.
- Improper altitude, velocity, or specialized function indication.

To reduce errors the path and point cards are input into a special program 'PMAP' for path processing and error checking. PMAP detects errors and presents messages relating to:

- Different paths having the same identifier.
- Path point sequence number irregularities, i.e., duplicate sequence numbers, not in sequence, and number of points not matching inputted total.
- Path point identifier not matching track identifier.
- Improper structure of UTM coordinates.
- Unusually long path leg or sharp turn as compared to selectable input references.

PMAP will list the input path and point data in tabular chart format which permits ease of scanning and error recognition. PMAP also plots each path on a UTM grid map. The scale of the grid map is input selectable. Based upon the known course of the track path, or physically comparing it to the track path map overlay, path errors are recognized readily. PMAP should be repeated after extensive error correction to insure path definition accuracy.

TACOS.5.5 Penetrators

TACOS.5.5.1 Requirements

Penetrator data requirements in TACOS include g limits; look-ahead ranges for terrain following; radar cross section (RCS) samples; penetration aids; total ordnance loads; and ordnance drop protection for different type targets. All penetrator vehicle types input into TACOS must be assigned a unique four character alphanumeric identifier. The maximum number of penetrator types allowed is 10.

TACOS.5.5.2 Source

Penetrator source data are from systems descriptions, intelligence summaries, and study scenario/attack plan.

TACOS.5.5.3 Procedures

TACOS.5.5.3.1 System Data

Penetrator systems defining data such as g limits and terrain following look-ahead ranges are obtained from documentation and associated directly with the particular penetrator type. Data such as altitude, velocity, and turn capabilities are used indirectly through awareness and consideration when developing the penetrator track paths. Penetrator vehicle data development may be dependent upon other factors besides aircraft characteristics. Radar cross section data for example is developed through consideration of the penetrator physical characteristics, aspect angles, and frequency bands of the ground air defense sensors. Total ordnance load is calculated and must be standard for a particular vehicle type. The number of units of ordnance to drop on a particular type system target may vary and must be designated individually per system type.

TACOS.5.5.3.2 Identifiers

Each input penetrator is associated with one or more penetrator vehicle paths via penetrator identifiers. Similar to Site and System identifiers, penetrator type identifiers may be selected to provide ease of subsequent

penetrator or functional recognition during analytical efforts. This may include penetrator identifier selection to force peculiar statistical reporting in RECAP. Penetrator identifier selection may be based upon the type of penetrator: fighter bomber, heavy bomber, reconnaissance, or ARM; mission assignment: close support, ground air defense suppression, or escort; and type or location of target: forward or rear target, SAM-D fire units, airbases, and communication centers. Since the number of penetrator type identifiers is limited to 10, careful study is required in large scale simulations to provide a penetrator identifier scheme that accurately portrays the penetrator and simplifies later analysis. Several examples of descriptive coding are presented as follows:

- PVAB → Penetrator against airbases
- RCCE → Reconnaissance Penetrator
- PVDV → Penetrator for close support in divisional area
- ØARM → Anti-radiation missile inputted as penetrator vehicle
- PVES → Penetrator escort
- M21F → MiG-21 Fishbed F
- TU22 → Tu-22 Blinder
- AØ4F → A-4F SKYHAWK

TACOS.5.6 Cell

TACOS.5.6.1 Requirements

Cell data requirements include developing and prescribing the size, number and timing of penetrator flights (cells) for each track path. Cells input into TACOS must be assigned unique four character alphanumeric identifiers.

TACOS.5.6.2 Source

Penetrator descriptions, intelligence summaries, study scenario/attack plan, PMAP output, and FRAG1B output.

TACOS.5.6.3 Procedures

TACOS.5.6.3.1 Timing Rationale

Cell timing is one of the key elements in structuring the attack model. The many purposes served by cell timing allow molding the composite paths to the precise demands of the scenario attack plan. The main attack will normally have major divisions that will require time phasing. A common example would be having ground air defense suppression occurring prior to attacking ground target. Within a major division, timing would serve to have a planned progression of events, e.g., ground air defense suppression may require progressive forward to rear ('roll-up') site suppression developing a corridor for low altitude penetration to rear areas. Another timing situation that may be desirable to represent involves planning to have events occur simultaneously. Examples may include penetrators in divisional ground attack crossing the FEBA simultaneously or time on target (TOT) being the same for bombers attacking various airbases. Cell timing may apply to an individual target attack to accommodate attack tactics. An airbase runway attack may require specific spacing of bomber runs to accomplish their mission.

TACOS.5.6.3.2 Timing Development

Cell timing for the various paths is an important procedure requiring careful study to develop accurately. The manual procedure to establish individual cell timing is not difficult. However, it will take considerably more effort to develop time correlations, phases, and tactics representations that are required to form the overall attack model.

If the paths were developed with forethought, PMAP and FRAG1B will present useful track path information. They provide a listing of each track path that includes accumulative time by path point from path beginning. Also, specialized function indicators that were input are shown for each path point. Therefore, if check points were established for area boundaries and targets or bomb release points, the time of flight to the particular

points along the path is readily obtainable. Through shifting of the time when the cell starts to proceed along the track path, various game events may be planned to occur simultaneously, at prescribed intervals, or during certain periods. Zero time is the common reference used for the amount of shift (Δt). Figure TACOS.5-2 illustrates cell time development.

TACOS.5.6.3.3 Cell Size

The specific size of cells will be developed and prescribed in the scenario/attack plan. The air attack planner will consider the type aircraft, target, and ordnance to develop suitable cell size and spacing. The allowable maximum number of objects per cell is 8.

TACOS.5.6.3.4 Identifiers

Cell identifiers are usually coded for ease of cross-reference to their related track path and to indicate the relative order of cells along a track path. Cells 101A and 101B could represent the first and second cells respectively, for track 101. Further illustrations are shown in Figure TACOS.5-3.

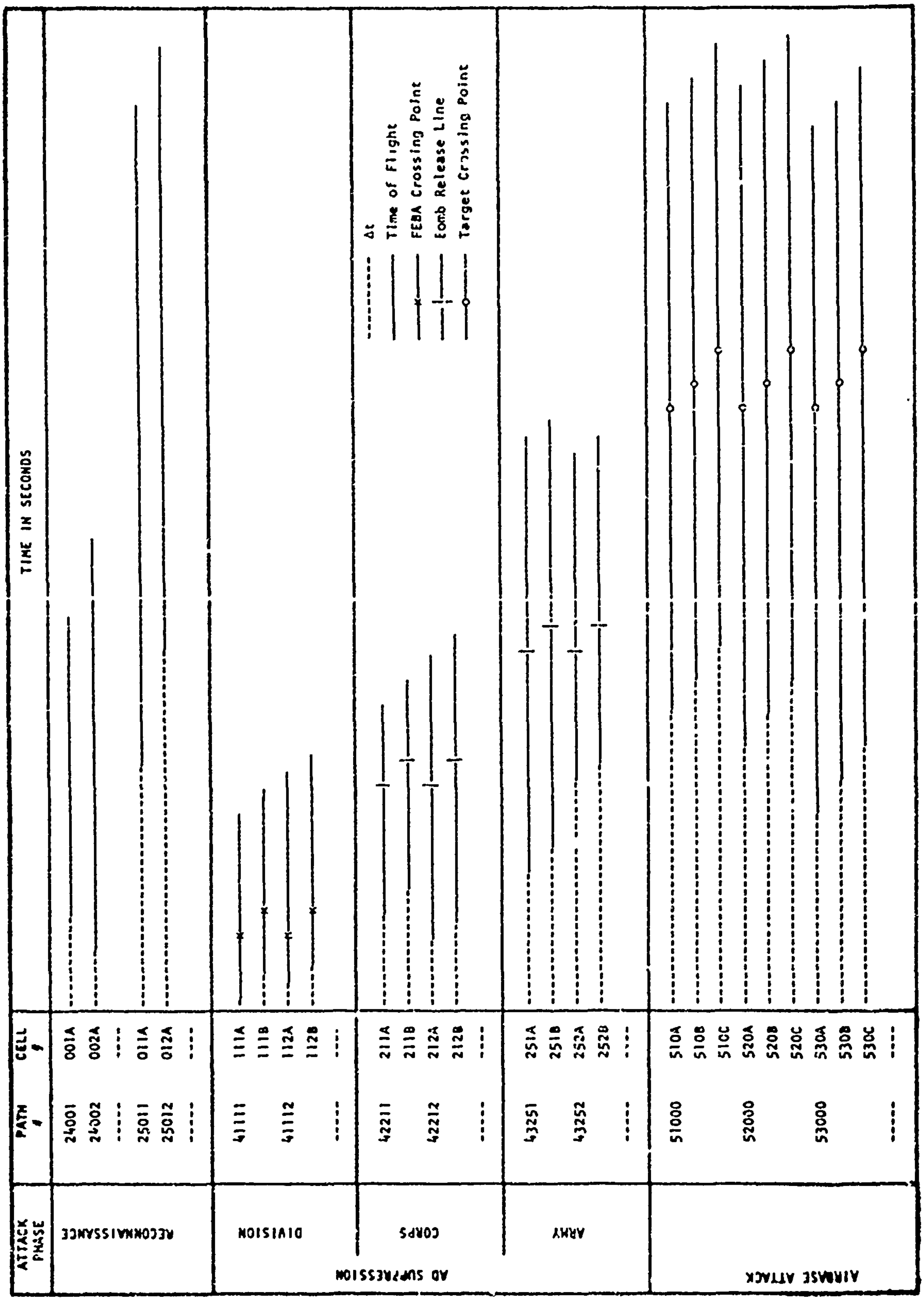


Figure TACOS.5-2. Cell Development Timing

Reconnaissance 2

of Ground Air Defense Suppression 4

Sequence # 0 0 1

PATH	2	4	0	0	1	
CELL			0	0	1	A

Sequence # 0 0 2

PATH	2	4	0	0	2	
CELL			0	0	2	A

of Airbase Attack 5

Sequence # 0 1 1

PATH	2	5	0	1	1	
CELL			0	1	1	A

Sequence # 0 1 2

PATH	2	5	0	1	2	
CELL			0	1	2	A

Ground Air Suppression Attack 4

Division area 1

CHAPARRAL 1

Site # 1 1

PATH	4	1	1	1	1	
1st CELL			1	1	1	A
2nd CELL			1	1	1	B

Site # 1 2

PATH	4	1	1	1	2	
1st CELL			1	1	2	A
2nd CELL			1	1	2	B

Figure TACOS.5-3. Path/Cell Coding

Corps area		2				
SAM-D			2			
Site #				1	1	
PATH	4	2	2	1	1	
1st CELL			2	1	1	A
2nd CELL			2	1	1	B
Site #				1	2	
PATH	4	2	2	1	2	
1st CELL			2	1	2	A
2nd CELL			2	1	2	B
Army area		3				
SAM-D			2			
Site #				5	1	
PATH	4	3	2	5	1	
1st CELL			2	5	1	A
2nd CELL			2	5	1	B
Site #				5	2	
PATH	4	3	2	5	2	
1st CELL			2	5	2	A
2nd CELL			2	5	2	B

Airbase Attack	5				
BITBURG		1	0	0	0
PATH	5	1	0	0	0
1st CELL	5	1	0	A	
2nd CELL	5	1	0	B	
3rd CELL	5	1	0	C	
Spangdahlem		2	0	0	0
PATH	5	2	0	0	0
1st CELL	5	2	0	A	
2nd CELL	5	2	0	B	
3rd CELL	5	2	0	C	

Figure TACOS.5-3. Path/Cell Coding (Continued)

Ramstein

		3	0	0	0
PATH	5	3	0	0	0
1st CELL	5	3	0	A	
2nd CELL	5	3	0	B	
3rd CELL	5	3	0	C	

Figure TACOS.5-3. Path/Cell Coding (Concluded)

CHAPTER TERAIN

TERAIN USER/PLANNER GUIDE

T.1 DETAILED DESCRIPTION OF MODULE FUNCTION

TERAIN is a CDC 6600 computer program designed to be used primarily as a generator of pictorial displays of site coverage. TERAIN utilizes Dominant Mask Function (DMF's) from FRAGIA to pictorially display and generate informative statistics about an air defense site's visible airspace. Specific regions of terrain may also be accessed and pictorial displays of digitized terrain data printed. These TERAIN displays are utilized by the analyst for assistance in selection of air defense site locations and weapons mixes.

TERAIN calculates the effect of terrain masking on an AD site by means of a Critical Altitude Function (CAF). A CAF is an array of altitude samples which describe the altitudes (about local terrain) at which a penetrator would have to climb to be visible at that site. Once the critical altitude has been determined at each terrain sample point, some significant means must be furnished for pictorially displaying this information. The type of pictorial display (called a coverage diagram) is selected by the analyst from the available types. A sample point for a quantized radar coverage diagram is illustrated in Figure T.1-1.

The overall effectiveness of the TERAIN program is enhanced by the generality of the coding structure. The TERAIN code is structured to accept control inputs in an operator/operand format. The user can pick and choose from the N operators and M operands, those which best describe his problem. This allows the user a great amount of flexibility in selection of the operator/operand combination which best describes his problem from the M*N valid output types.

The data flow for TERAIN is shown in Figure T.1-2. Basically, TERAIN generates Critical Altitude Functions (CAF's) from the FRAGIA-generated DMF's and the input digitized terrain data file. These CAF's are then utilized for generation of coverage diagrams.

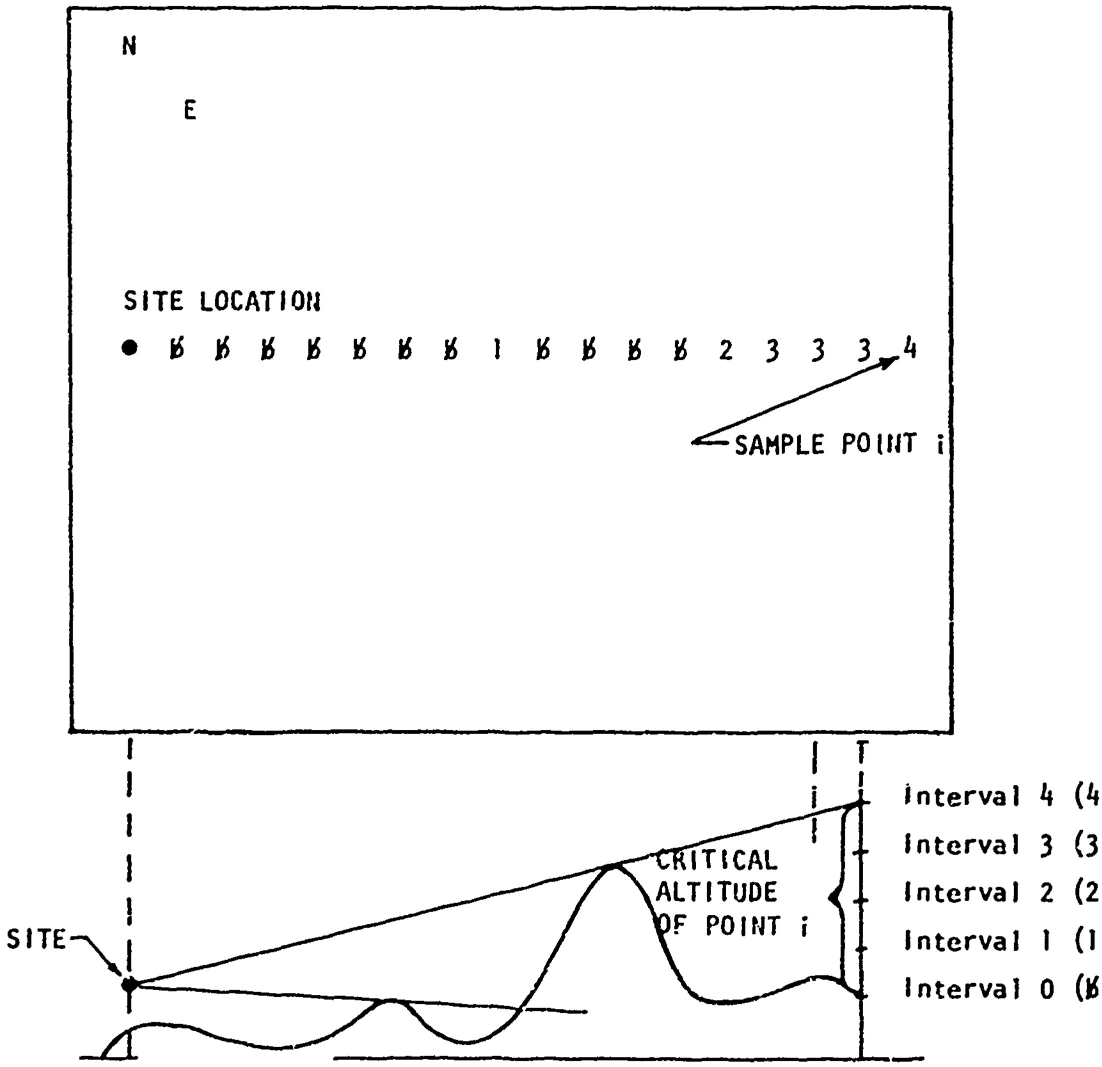


Figure T.1-1. Sample Point for Quantized Radar Coverage Diagram

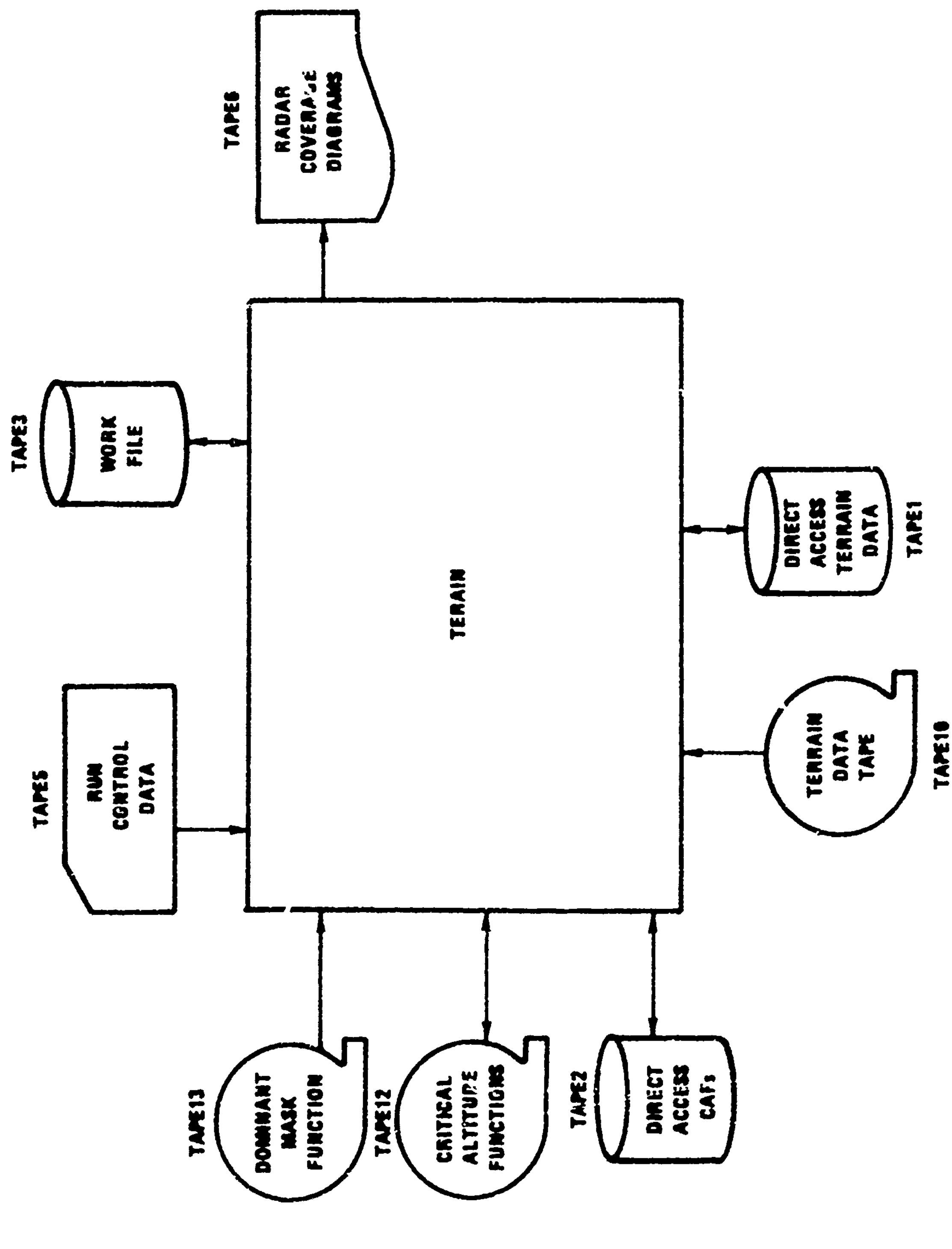


Figure T.1-2. TERAIN Data Flow

T.1.1 Submodels Used

TERAIN utilizes the following five submodels: Terrain Data Collation, Critical Altitude Function Generation, Critical Altitude Function Recording, Statistics Generation, and Coverage Diagram Generation.

T.1.1.1 Terrain Data Collation

Terrain Data Collation is the process by which the terrain data for the required area maps are read from mass storage and stored in the central memory. Collation consists of determining the terrain records required, reading these records into central memory, one by one, so that no unnecessary seeks or reads are required and transferring the useful parts of these records into the area map in central memory.

T.1.1.2 Critical Altitude Function Generation

In order to produce a coverage diagram, TERAIN must first calculate the site Critical Altitude Function. A critical altitude is that altitude above local terrain at which a point, rising from the ground, first becomes visible to an air defense site. The Critical Altitude Function is then an array of altitudes, corresponding to the terrain sample points, to which a vehicle must climb in order to become visible by this site.

T.1.1.3 Critical Altitude Function Recording

Each Critical Altitude Function generated by TERAIN may be recorded on magnetic tape for subsequent TERAIN usage or for use by the Quick Response Tactical Air Defense Computer Operational Simulation (QR-TACOS). These CAF's are recorded in a series of 1717 word logical records. The first 79 words of the first record contain the site and map data. The remainder of this record and the following records contain the quantized CAF.

T.1.1.4 Statistics Generation

TERAIN statistics can be generated by sectioning the space inside a cylinder surrounding a site and counting the number of critical altitude points inside each volume. The airspace surrounding the site is sectioned into curvilinear cubes by defining azimuth sector, range, and altitude brackets. A table is printed of the total number of points in each volume.

T.1.1.5 Coverage Diagram Generation

After CAF generation, coverage diagrams may be printed to illustrate site coverage. These diagrams may take on any of several forms depending on the information the analyst requests. The Coverage Diagram Generation Submodel determines the CAF or CAF(s) influence, selects the characters to be printed and prints the coverage diagram.

T.1.2 Run Resources Required

TERAIN requires the following resources for running:

- CDC 6600 computer with at least a 53248 word (decimal) ($150,000_8$) region available.
- Three tape drives, one each for the terrain data input, the Critical Altitude Function file, and the Dominant Mask Function file.
- Random access mass storage device for storage of the terrain data file, the direct access CAF's and work file.
- A card reader suitable for control data input.
- A printer capable of either 6 or 8 lines per inch (both not necessary) and character overprint.
- A terrain data tape containing the digitized terrain data for the regions of interest.
- Either a DMF tape or CAF tape for the sites whose coverage diagrams are to be generated.
- Input cards describing the types of coverage diagrams be generated.

T.2 DATA REQUIREMENTS

TERAIN requires the quantized terrain data for the region under consideration. UTM grid zones for which data are currently available are 32UF for West Germany (with foliage), 32U for West Germany (without foliage), 00A for Okinawa, 51S for Korea (West zone), 52S for Korea (East zone) and 19T for Boston. The terrain data tape format is detailed in the FFAGI

Programmer/Analyst Guide. Either a previously generated CAF tape or a DMF tape generated by FRAG1A will be required. The tape format for the DMF tape is detailed in the FRAG1 Programmer/Analyst Guide. The CAF tape format is detailed in the TERAIN/PMAP/SØRTEV Programmer/Analyst Guide.

T.2.1 Card Type Functional Definitions

The input control cards for TERAIN are free format and optionally contain 3 fields: a name field, operator field and operand field. The fields must be separated by at least one blank and can appear only in that order. The name field must conform to the following:

- Must start in card column one.
- May be one to eight characters. Only first four are stored.
- First character may not be blank.
- May be omitted under certain applications.

The operator field must conform to the following:

- Must be separated from name field by at least one blank. If no name field, may start card columns 2-71.
- Must be 'DØ', 'MULT', 'AREA' or 'SET'.
- An error is indicated if an operator field is not present.

The operand field consists optionally of keywords and parameter fields and must conform to the following:

- A keyword is separated from the operator field by at least one blank or from other keywords by a comma. Only the first four characters are stored.
- Consists of at least one keyword, followed optionally by parameters.
- If the keyword has one or more parameters, the keyword must be followed by an equal sign.

- If more than one parameter is entered per keyword, these must be enclosed within parentheses and separated by commas. That is = (parm, parm)
- If only one parameter is specified there must be no parentheses. = parm.
- The parameter may be floating, fixed, or alphanumeric. If alphanumeric, only the first four characters are stored.
- A UTM grid coordinate counts as two parameters even though written as one.
- Continuation is indicated by following the last keyword or parameter by a comma, placing an X in card column 72 and starting the continuation card in card column 16.

T.2.1.1 Name Fields

A name field must contain either a blank, a site (DMF) identifier, of a UTM grid zone identifier. A blank name field is required for a 'MULT' operator or a 'SET' operator. The identifier of the site or UTM grid zone is entered for 'DØ' operators. An 'AREA' operator requires a UTM grid zone name. For further explanation, see T.2.3.

T.2.1.2 Operator Type Functional Definitions

The operator field must contain one of four valid operators: 'SET', 'DØ', 'MULT' or 'AREA'.

T.2.1.2.1 'SET' Type Operator Field

The SET operator field causes the options, formats, or scales specified in the operand field to become the default values for the entire TERAIN run.

T.2.1.2.2 'DØ' Type Operator Fields

The 'DØ' type operator always has a non-blank name field which specifies the site name for coverage diagram generation or the UTM grid zone name for terrain input. Only one 'DØ' type card may be input for each site name.

T.2.1.2.3 'MULT' Type Operator Field

The 'MULT' type operator is used to generate multisite coverage diagrams to determine how many sites can see a point or which sites can see a point. There may be only one MULT card for each TERAIN run, but this card may have any number of continuations.

T.2.1.2.4 'AREA' Type Operator Fields

Operator 'AREA' is used to print maps of actual terrain. The name field must specify the name of the grid zone under consideration and the first parameter must be 'GET'.

T.2.1.3 Keyword Type Functional Definitions

This paragraph contains the functional definitions for the keywords and a definition of the parameters which may be used with each keyword. Table T.2-1 presents a cross-reference for determination of which operators may be used with which keywords. The keywords which change scale factors, diagram formats, and printing may be used with all the valid operator types. If these keywords appear on a 'SET' operator card, these are entered as permanent default values for a complete TERAIN run. However, if these keywords are entered for a 'DØ', 'MULT', or 'AREA' operator, they must be entered prior to the diagram request to which they refer and are only in effect for that card and card continuation. These keywords may be reset any number of times on one card. For definitions of map types, see T.4.

T.2.1.3.1 BMAP Fields

BMAP = ref. or BMAP = (ref1, ref2, ref3...)

A Boolean radar coverage map for each reference altitude is printed at the assumed scale. Reference altitude is integer meters above local terrain.

T.2.1.3.2 QMAP Fields

QMAP = iquant or QMAP = (iquant1, iquant2,...)

A quantized function map is produced using the integer iquant as the quantization interval. One map is done for each parameter. If on an AREA card, it produces a map of terrain, if on 'DØ' card, it produces a quantized radar coverage map.

TABLE T.2-1

TABLE OPERATOR/OPERAND CROSS-REFERENCE

OPERATOR FIELDS KEYWORD USAGE	DØ	MULTI	SET	AREA
BMAP COVERAGE DIAGRAMS	X			X
QMAP COVERAGE DIAGRAMS	X			X
MULTIMAP COVERAGE DIAGRAMS	X			X
MØDMAP COVERAGE DIAGRAMS	X			X
ØVMAP COVERAGE DIAGRAMS	X			X
ØVMULTIMAP COVERAGE DIAGRAMS	X			X
ANDMAP COVERAGE DIAGRAMS		X		
ØRMAP COVERAGE DIAGRAMS		X		
ØVPØRMAP COVERAGE DIAGRAMS		X		
TABMAP TABULAR MAP	X	X		X
SCALE DIAGRAM SCALE	X	X	X	X
RØUND DIAGRAM FORMAT	X	X	X	X
CØNTØUR DIAGRAM FORMAT	X	X	X	X
NLPI LINE SPACING	X	X	X	X
NLPP PAGE SIZE	X	X	X	X
DEBUG DEBUG OUTPUT	X	X	X	X
CHAR PRINT FORMAT	X	X	X	X
GET DATA INPUT	X	X		X
SAVE DATA MANAGEMENT	X		X	X
ØRIG DATA INPUT	X		X	
STAT DATA OUTPUT	X			X
NØLØAD CAF INPUT			X	

T.2.1.3.3 MULTIMAP Fields

MULTIMAP = (iref1, iref2,...)

One map is produced showing coverage at all reference altitudes. The character set used may be changed with 'CHAR'.

T.2.1.3.4 MØDMAP Fields

MØDMAP = iquant or MØDMAP = (iquant1, iquant2,...)

Two maps result from each iquant, one is a QMAP and the second is a QMAP with iquant2 = 36*iquant1.

T.2.1.3.5 ØVMAP Fields

ØVMAP = iquant or ØVMAP = (iquant1, iquant2,...)

One map results. It is like both of the maps from a MØDMAP overprinted.

T.2.1.3.6 ØVMULTIMAP Fields

ØVMULTIMAP = (iref1, iref2,...)

One map results showing the Boolean coverage at the specified altitudes overprinted. The number of reference altitudes cannot be greater than four. Character set may be changed with 'CHAR'.

T.2.1.3.7 ANDMAP Fields

ANDMAP = (iref, coord lower left, coord upper right, site1, site2,...)

One map results showing, of the sites listed, how many sites can see a point at the reference altitude. The max number of sites is 27. Must appear only on a 'MULT' card.

T.2.1.3.8 ØRMAP Fields

ØRMAP = (iref, coord lower left, coord upper right, site1, site2,...)

One map results showing which site can see a point at the reference altitude. Max number of sites = 4. Can only appear on a 'MULTI' card.

T.2.1.3.9 ØVØRMAP Fields

ØVØRMAP = (iref, coord lower left, coord upper right, site1, site2,...)

Same as ØRMAP except instead of using 16 symbols to show who can see a point, four symbols are used and the combined point coverage is shown by overprinting the symbols (how many sites can see a point). Can only appear on a 'MULT' card.

T.2.1.3.10 TABMAP Fields

TABMAP

A tabular data map is printed for the map in core. A 100 km square requires 50 pages. A 20 km square requires four pages.

T.2.1.3.11 SCALE Field

SCALE = N Meters

The scale is changed to N meters/inch.

T.2.1.3.12 NLPI Field

NLPI = ival

Number of lines per inch is set to ival. Assumed option is 6.

T.2.1.3.13 NLPP Field

NLPP = ival

Number of line per page is set to ival. Assumed option is 55.

T.2.1.3.14 DEBUG Fields (Not Implemented)

DEBUG = (ABCD, EFGH)

Sets Debug switches: Multipunch 12, 0, 9, 8, 1 = off
Multipunch 12, 9, 1 = on

A = Subroutine THETA
B = CAF
C = CAF
D = AND
E = DATA
F = MAIN & RECCAF
G = PRTMAP
H = PRTMAP & CHØSCH

T.2.1.3.15 CHAR Fields

CHAR = (Ꮻ-1XO$*=, ABCD, EFGH)

The four words are inserted into the character set for ØVØRMAP, ØVMULTIMAPs and MULTIMAPs. The above values are assumed. One to four words may be changed. If only the first is to be changed, only one word is needed. If the last is to be changed, all four words are needed. If not on 'SET' card, change is only temporary.

T.2.1.3.16 GET Field

GET = (lower left corner, upper right corner, MØDE)

This keyword obtains the area specified by the lower left corner coordinate and upper right coordinate. Cannot specify area greater than a 100 km square. The specified area is put in core so maps may be printed from it. Should appear on 'AREA' card before any maps are requested.

The parameter 'MØDE' is optional and is used to mathematically manipulate two terrain data files. Terrain data from the CAF tape can be substracted (MØDE=1), added (MØDE=2), multiplied (MØDE=3), divided (MØDE=4), or have the foliage flagged (MØDE=5) by the map in central memory.

T.2.1.3.17 ØRIGIN Field

ØRIGIN = (Origin)

The grid zone is entered in the KGZ and origin is set. SETØRG is called. There still must have been a DMF file defined, but this resets the origin.

ØRIG = KT

The grid zone must be the name field of the card.

T.2.2 <u>Input Data Deck Sequencing</u>

Figure T.2-1 is a typical input data deck sequence for TERAIN. Although the input sequence has no effect on program operation, this figure illustrates a typical run.

T.2.3 <u>Input Variables Definitions, Usages, Instructions, and Formats</u>

This paragraph contains a detailed description of each TERAIN type input card in tabular form. The information presented includes the

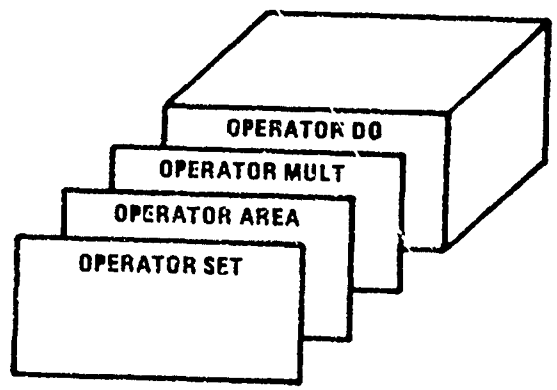


Figure T.2-1. TERAIN Input Data Deck Sequencing

TACOS PROGRAM: TERAIN | OPERATOR TYPE: SET | FUNCTIONAL USE: Set permanent map parameters

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A SET type card need be input only to set parameters for the entire TERAIN run. A name field will only be specified if the keyword is ØRIG.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
SCALE	1	1		T.4. MAIN-I VOL II D	Scale factor for coverage diagram in meters per printed inch.
RØUND	0	N.A.	N.A.	T.4. MAIN-I VOL II D	Selects the round format for map printing.
CØNTØUR	0	N.A.	N.A.	T.4. MAIN-I VOL II D	Selects the contour format for map printing.
NLPI	1	1	6 or 8	T.4. MAIN-I VOL II D	Selects a printer spacing to be used in calculation of the map size. The default value is 6 lines per inch. Integer
NLPP	1	1	NLPP≤62	T.4. MAIN-I VOL II D	The number of lines to be printed per page at the specified printer spacing. The default value is 55. Integer

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TACOS PROGRAM: TERAIN | OPERATOR TYPE: SET (Cont'd) | FUNCTIONAL USE: Set permanent map parameters

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A SET type card need be input only to set parameters for the entire TERAIN run. A name field will only be specified if the keyword is ØRIG.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
DEBUG	2	1	N.A.	T.4. MAIN-1 VOL II D	* Four character alphanumeric debug code. Character position one specifies debug option from subroutine THETA. Character position two specifies debug option for map print from subroutine CAF. Character position three specifies debug option for timing of subroutine CAF. Character position four specifies debug option from subroutine ANDSUB.
		2	N.A.		* Four character alphanumeric debug code. Character position one specifies debug option from subroutine DATA. Character position two specifies debug option from subroutine MAIN and RECCAF. Character position three specifies debug option from subroutine PRTMAP. Character position four specifies debug option from subroutine CHØSCH.

NOTE: The multipunch 12-0-9-8-1 sets flag FALSE, and multipunch 12-9-1 sets the flag TRUE. The default option is FALSE. (NOT IMPLEMENTED)

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TACOS PROGRAM: TERAIN	OPERATOR TYPE: SET (Cont'd)	FUNCTIONAL USE: Set permanent map parameters

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A SET type card need be input only to set parameters for the entire TERAIN run. A name field will only be specified if the keyword is ØRIG.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
CHAR	1-4	1-4	N.A.	T.4. MAIN-I VOL II D	Four alphanumeric characters to be used for ØVØRMAP and ØVPMULTIMAP plots. Up to sixteen characters (four for each parameter) may be changed.
SAVE	0-149	1-149	N.A.	T.4. MAIN-I VOL II D	Saves the Critical Altitude Functions generated from the DMF tape. No parameters saves all. If parameters are specified only the CAF's whose four character site names were specified will be saved.
ØRIGIN	1	1	N.A.	T.4. MAIN-I VOL II D	UTM grid square designator of the coordinate system origin. The name field must be the grid zone designator corresponding to this coordinate system origin.
NØLØAD	0	N.A.	N.A.	T.4. MAIN-I VOL II D	The CAF tape will not be read if NØLØAD is specified.

BDM/A 480-10-73

TACOS PROGRAM: TERAIN | OPERATOR TYPE: AREA | FUNCTIONAL USE: Print AREA type maps

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: An AREA type card need be input only if maps are to be printed from terrain data or manipulated terrain data. The name field must be the grid zone designator corresponding to the area under consideration.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
BMAP	1-149	1-149	≥ 0	T.4. MAPER-E VOL II D	A Boolean radar coverage diagram is printed for each parameter at the prespecified scale. Parameters are reference altitudes in integer meters.
QMAP	1-149	1-149	≥ 0	T.4. MAPER-E VOL II D	A quantized radar coverage diagram is printed for each parameter at the prespecified scale. Parameters are quantization intervals in integer meters.
MULTIMAP	1-15	1-15	≥ 0	T.4. MAPER-E VOL II D	One multireference Boolean radar coverage diagram is printed at the prespecified scale. Parameters are reference altitudes in integer meters.
MØDMAP	1-149	1-149	≥ 0	T.4. MAPER-E VOL II D	Two diagrams result from each parameter. One is a QMAP with the parameter being the quantization interval. The second is a remainder map (QMAP of the remainder' with the quantization interval set to 36* parameter.) Parameters are quantization intervals in integer meters.

BDM/A 480-10-73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: AREA (Cont'd)	FUNCTIONAL USE: Print AREA type maps

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: An AREA type card need be input only if maps are to be printed from terrain data or manipulated terrain data. The name field must be the grid zone designator corresponding to the area under consideration.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
ØVMAP	1-149	1-149	≥ 0	T.4. MAPER-E VOL II D	One diagram is printed for each parameter. This diagram will be a resultant over print of a remainder and quotient type MØDMAP. Parameters are quantization intervals in integer meters.
ØVMULTIMAP	1-4	1-4	≥ 0	T.4. MAPER-E VOL II D	An overprinted multireference Boolean radar coverage diagram results. The parameters are reference altitudes in integer meters.
TABMAP	0	N.A.	N.A.	T.4. MAPER-E VOL II D	The core map array is printed on about 57 pages for a 100 km square.
SCALE	1	1	≥ 0	T.4. MAIN-I VOL II D	Scale factor for coverage diagram in meters per printed inch. Integer.
RØUND	0	N.A.	N.A.	T.4. MAIN-I VOL II D	Selects the round format for map printing
CØNTØUR	0	N.A.	N.A.	T.4. MAIN-I VOL II D	Selects the contour format for map printing.
NLPI	1	1	6 or 8	T.4. MAIN-I VOL II D	Selects a printer spacing to be used in calculation of the map size. The default option is 6 lines per inch. Integer

BDM/A 480-10-73

TACOS PROGRAM: TERAIN	OPERATOR TYPE AREA (Cont'd)	FUNCTIONAL USE: Print AREA type maps.

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: An AREA type card need be input only if maps are to be printed from terrain data or manipulated terrain data. The name field must be the grid zone designator corresponding to the area under consideration.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
NLPP	1	1	NLPP$\leq$62	T.4. MAIN -1 VOL II D	The number of lines to be printed per page at the specified printer spacing. The default option is 55. Integer
GET	4 or 5	1-5	N.A.	T. 4. MAIN-1 VOL II D	Gets area from terrain file and puts these data in core so maps can be generated from it. First two parameters are the UTM coordinate of the map SW corner (2 letter - 8 digit). Third and fourth parameters are the UTM coordinates of the map NE corner (2 letters - 8 digit). If a fifth parameter is specified, the GET map will be operated on by the map in central memory. This last parameter specifies mode. 1 = subtract 2 = add 3 = multiply 4 = divide 5 = flag foliage

BDM/A 480-10-73

TACOS PROGRAM: TERAIN | **OPERATOR TYPE:** AREA (Cont'd) | **FUNCTIONAL USE:** Print AREA type maps.

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: An AREA type card need be input only if maps are to be printed from terrain data or manipulated terrain data. The name field must be the grid zone designator corresponding to the area under consideration.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
DEBUG	2	1	N.A.	T.4.MAIN-1 Vol. IIB	Four character alphanumeric debug code. Character position one specifies debug option from subroutine THETA. Character position two specifies debug option for map print from subroutine CAF. Character position three specifes debug option for timing of subroutive CAF. Character position four specifies debug option from subroutive ANDSUB.
		2	N.A.		Four char . ter alphanumeric debug code. Character position one specifies debug option from subroutine DATA. Character position two specifies debug option from subroutines MAIN and RECCAF. Character position, three specifies debug option from subroutine PRTMAP. Character position four specifies debug option from subroutine CHØSCH.

NOTE: The multipunch 12-0-9-8-1 sets flag FALSE, and multipunch 12-9-1 sets the flag TRUE. The default option is FALSE. (NOT IMPLEMENTED)

BDM/A 130 10 73

TACOS PROGRAM: TERAIN | OPERATOR TYPE: AREA (Cont'd) | FUNCTIONAL USE: Print AREA type maps.

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: An AREA type card need be input only if maps are to be printed from terrain data or manipulated terrain data. The name field must be the grid zone designator corresponding to the area under consideration.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
CHAR	1-4	1-4	N.A.	T.4.MAIN-I Vol. IID	Four alphanumeric characters to be used for ØVØRMAP and ØVPMULTIMAP plots. Up to sixteen characters (four for each parameter) may be changed.
SAVE	0	N.A.	N.A.	T.4.MAIN-I Vol. IID	Specifies the critical altitude function generated from the DMF tape are to be added to the CAF tape. No parameters.

BDM A 480 10 73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: MULT	FUNCTIONAL USE: Control production of multisite coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A MULT type card is required for ANDMAP, ØRMAP, or ØVPØRMAP printing. No name field is allowed on a MULT type card. Only one MULT type card may be read per TERAIN run. However, any number of continuations are allowed.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
ANDMAP	6-40			T.4.MAPER-E Vol. IID	One coverage diagram results showing of the sites listed, how many sites can see a point at the reference altitude. Map size must be no large: than 100 km square.
		1	≥ 0		
		2, 3	N.A. 0-99999999		Reference altitude in integer meters.
		4, 5	N.A. 0-99999999		UTM coordinates of the NE corner of the area under consideration. (2 letter - 8 digit) - (0,0) gives a 100 km square.
		6-40	N.A.		Site indentifiers. This is the name of the CAF's that will be used for ANDMAP generation.

BDM/A 480 10 73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: MULT (Cont'd)	FUNCTIONAL USE: Control production of multisite coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A MULT type card is required for ANDMAP, ØRMAP, or ØVPØRMAP printing. Only one MULT type card may be read per TERAIN run. No name field is allowed on a MULT type card.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
ØRMAP	6-9			T.4.MAPER-E Vol. IID	One overprinted coverage diagram results showing which of the sites listed can see a point at the specified reference altitude.
		1	≥ 0		Reference altitude in integer meters.
		2, 3	N.A. 0-99999999		UTM coordinates of the SW corner of the area under consideration (2 letter - 8 digit)
		4, 5	N.A. 0-99999999		UTM coordinates of the NE corner of the area under consideration (2 letter - 8 digit)
		6-9	N.A.		Site identifiers. This is the name of the CAFs that will be used for ØVPØRMAP generation.

BDM/A 480 10-73

TACOS PROGRAM: TERAIN | OPERATOR TYPE: MULT (Cont'd) | FUNCTIONAL USE: Control production of multisite coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A MULT type card is required for ANDMAP, ØRMAP, or ØVPØRMAP printing. Only one MULT type card may be read per TERAIN run. No name field is allowed on a MULT type card.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
ØVPØRMAP	6-9			T.4.MAPER-E Vol. IID	One coverage diagram results showing which of the sites listed can see a point at the specified reference altitude.
		1	≥ 0		Reference altitude in integer meters.
		2, 3	N.A. 0-99999999		UTM coordinates of the SW corner of the area under consideration. (2 letter - 8 digit)
		4, 5	N.A. 0-99999999		UTM coordinates of the NE corner of the area under consideration. (2 letter - 8 digit)
		6-9	N.A.		Site identifiers. This is the name of the CAF's that will be used for ØVPØRMAP generation.

BDWA 480 10 73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: MULT (Cont'd)	FUNCTIONAL USE: Control production of multisite coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A MULT type card is required for ANDMAP, ØRMAP, or ØVPØRMAP printing. Only one MULT type card may be read per TERAIN run. No name field is allowed on a MULT type card.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
SCALE	1	1	≥ 0	T.4.MAIN-1 Vol. IID	Scale factor for coverage diagram in meters per printed inch. Integer.
RØUND	0	N.A.	N.A.	T.4.MAIN-1 Vol. IID	Selects the round format for map printing.
CØNTØUR	0	N.A.	N.A.	T.4.MAIN-1 Vol. IID	Selects the contour format for map printing.
NLPI	1	1	6 or 8	T.4.MAIN-1 Vol. IID	Selects a printer spacing to be used in calculation of the map size. The default option is 6 lines per inch. Integer.
NLPP	1	1	NLPP $\geq$ 62	T.4.MAIN-1 Vol. IID	The number of lines to be printed per page at the specified printer spacing. The default option is 55. Integer.

BDM/A 480 10-73

TACOS PROGRAM: TERAIN | OPERATOR TYPE: MULT (Cont'd) | FUNCTIONAL USE: Control production of multisite coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A MULT type card is required for ANDMAP, ØRMAP, or ØVPØRMAP printing. Only one MULT type card may be read per TERAIN run. No name field is allowed on a MULT type card.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
DEBUG	2	1	N.A.	T.4. MAIN-I VOL II D	*Four character alpharumeric debug code. Character position one specifies debug option from subroutine THETA. Character position two specifies debug option for map print from subroutine CAF. Character position three specifies debug option for timing of subroutine CAF. Character position four specifies debug option from subroutine ANDSUB.
		2	N.A.		*Four character alphanumeric debug code. Character position one specifies debug option from subroutine DATA. Character position two specifies debug option from subroutine MAIN and RECCAF. Character position three specifies debug option from subroutine PRTMAP. Character position four specifies debug option from subroutine CHØSCH.

NOTE: The multipunch 12-0-9-8-1 sets flag FALSE, and multipunch 12-9-1 sets the flag TRUE. The default option if FALSE. (NOT IMPLEMENTED)

BDM/A 480 10 73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: MULT (Cont'd)	FUNCTIONAL USE: Control production of multisite coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A MULT type card is required for ANDMAP, ØRMAP, or ØVPØRMAP printing. Only one MULT type card may be read per TERAIN run. No name field is allowed on a MULT type card.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
CHAR	1-4		N.A.	T.4. MAIN-I VOL II D	Four alphanumeric characters to be used for ØVØRMAP and ØVPMULTIMAP plots. Up to sixteen characters (four for each parameter) may be changed.
TABMAP	0	N.A.	N.A.	T.4. MAIN-I VOL II D	The core map array is printed on about 57 pages for a 100 km square.
GET	4-5	1-5	N.A.	T.4. MAIN-I VOL II D	Gets area from terrain file and puts these data in core so maps can be generated from it. First two parameters are the UTM coordinates of the map SW corner (2 letter-8 digit). Third and fourth parameters are the UTM coordinates of the map NE corner (2 letter - 8 digit). If a fifth parameter is specified, the GET map will be operated on by the map in central memory. This last parameter specifies mode. 1 = subtract 2 = add 3 = multiply 4 = divide 5 = flag foliage

BDM A 480 10-73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: DØ	FUNCTIONAL USE: Control production of coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A DØ type card is required for BMAP, QMAP, MULTIMAP, MØDMAP, ØVMAP, ØVMULTIMAP, or TABMAP printing or STAT table generation. Any or all of these diagrams may be printed from one DØ type card. The name field for a DØ type card must be the name of the site under consideration for diagram production or the UTM grid zone designator for keyword GET.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
BMAP	1-149	1-149	≥ 0	T.4.MAPER-E VOL.IID	A Boolean radar coverage diagram is printed for each parameter at the prespecified scale. Parameters are reference altitudes in integer meters.
QMAP	1-149	1-149	≥ 0	T.4.MAPER-E VOL.IID	A quantized radar coverage diagram is printed for each parameter at the prespecified scale. Parameters are quantization intervals in integer meters.
MULTIMAP	1-15	1-15	≥ 0	T.4.MAPER-E VOL.IID	One multireference Boolean radar diagram is printed at the prespecified scale. Parameters are reference altitudes in integer meters.
MØDMAP	1-149	1-149	≥ 0	T.4.MAPER-E VOL.IID	Two diagrams result from each parameter. One is a QMAP with the parameter being the quantization interval. The second is a remainder map (QMAP of the remainder with the quantization interval set to 36* parameter.) Parameters are quantization intervals in integer meters.

BDM/A 480 10-73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: DØ (Cont'd)	FUNCTIONAL USE: Control production of coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A DØ type card is required for BMAP, QMAP, MULTIMAP, MØDMAP, ØVMAP, ØVMULTIMAP, or TABMAP printing or STAT table generation. Any or all of these diagrams may be printed from one DØ type card. The name field for a DØ type card must be the name of the site under consideration for diagram production or the UTM grid zone designator for keyword GET.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
ØVMAP	1-149	1-149	$\geq$ 0	T.4.MAPER-E VOL.IID	One diagram is printed for each parameter. This diagram will be a resultant overprint of a remainder and quotient type MØDMAPS. Parameters are quantization intervals in integer meters.
ØVMULTIMAP	1-4	1-4	$\geq$ 0	T.4.MAPER-E VOL.IID	An overprinted multireference Boolean radar coverage diagram results. The parameters are reference altitudes in integer meters.
TABMAP	0	N.A.	N.A.	T.4.MAPER-E VOL.IID	The core map array is printed on about 57 pages for a 100 km square.
SCALE	1	1	$\geq$ 0	T.4.MAIN-I VOL.IID	Scale factor for coverage diagram in meters per printed inch.
RØUND	0	N.A.	N.A.	T.4.MAIN-I VOL.IID	Selects the round format for map printing.
CØNTØUR	0	N.A.	N.A.	T.4.MAIN-I VOL.IID	Selects the contour format for map printing.

BDM/A 480 10-73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: DØ (Cont'd)	FUNCTIONAL USE: Control production of coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A DØ type card is required for BMAP, QMAP, MULTIMAP, MØDMAP, ØVMAP, ØVMULTIMAP, or TABMAP printing or STAT table generation. Any or all of these diagrams may be printed from one DØ type card. The name field for a DØ type card must be the name of the site under consideration for diagram production or the UTM grid zone designator for keyword GET.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
NLPI	1	1	6 or 8	T.4.MAIN-I VOL.IID	Selects a printer spacing to be used in calculation of the map size. The default option is 6 lines per inch. Integer
NLPP	1	1	NLPP<6^	T.4.MAIN-I VOL.IID	The number of lines to be printed per page at the specified printer spacing. The default option is 55. Integer
GET	4-5	1-5	N.A.	T.4.MAIN-I VOL.IID	Gets area from terrain file and puts this data in core so maps can be generated from it. First two parameters are the UTM coordinates of the map SW corner (2 letter - 8 digit). Third and fourth parameters are the UTM coordinates of the map NE corner (2 letter - 8 digit). If a fifth parameters is specified, the GET map will be operated on by the map in central memory. This last parameter specifies mode. 1 = subtract 2 = add 3 = multiply 4 = divide 5 = flag foliage The name field for GET must be the grid zone designator for the area under consideration.

BDM A 480 10-73

TACOS PROGRAM: TERAIN | OPERATOR TYPE: DØ (Cont'd) | FUNCTIONAL USE: Control production of coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A DØ type card is required for BMAP, QMAP, MULTIMAP, MØDMAP, ØVMAP, ØVMULTIMAP, or TABMAP printing or STAT table generation. Any or all of these diagrams may be printed from one DØ type card. The name field for a DØ type card must be the name of the site under consideration for diagram production or the UTM grid zone designator for keyword GET.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
DEBUG	2	1	N.A.	T.4.MAIN-1 VOl.IID	*Four character alphanumeric debug code. Character position one specifies debug option from subroutine THETA. Character position two specifies debug option for map print from subroutine CAF. Character position three specifies debug option for timing of subroutine CAF. Character position four specifies debug option from subroutine ANDSUB.
		2	N.A.		*Four character alphanumeric debug code. Character position one specifies debug option from subroutine DATA. Character position two specifies debug option from subroutine MAIN and RECCAF. Character position three specifies debug option from subroutine PRIMAP. Character position four specifies debug option from subroutine CHØSCH.

NOTE: The multipunch 12-9-8-1 sets flag FALSE, and multipunch 12-9-1 sets the flag TRUE. The default option is FALSE. (NOT IMPLEMENTED)

BDM/A 48C 10-73

TACOS PROGRAM: TERAIN | OPERATOR TYPE: DØ (Cont'd) | FUNCTIONAL USE: Control production of coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A DØ type card is required for BMAP, QMAP, MULTIMAP, MØDMAP, ØVMAP, ØVMULTIMAP, or TABMAP printing or STAT table generation. Any or all of these diagrams may be printed from one DØ type card. The name field for a DØ type card must be the name of the site under consideration for diagram production or the UTM grid zone designator for keyword GET.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
STAT	8-32	Free field with parenthesis		T.4.STAT-D VOL.IID	Produce a statistical table output of the specified CAF. Counts data points within bracketed volumes.
		SECT			The parameter which immediately precedes this parameter specifies the number of azimuth sectors to be considered. Integer. Limit 36.
		RANGES			The parameter which immediately precedes this parameter specifies the number of range brackets (NRNGS) to be considered. Integer. Limit 5.
					The NRNGS parameters which immediately follow this parameter specifies the range brackets to be considered. Integer. Limit 5.
		ALTITUDES			The parameters which immediately precede this parameter specifies the number of altitude brackets (NALTS) to be considered. Integer. Limit 6.
					The NALTS parameters which immediately follow this parameter specifies the altitude brackets to be considered. Integer. Limit 6

BDM A 480 10 73

TACOS PROGRAM: TERAIN	OPERATOR TYPE: DØ (Cont'd)	FUNCTIONAL USE: Control production of coverage diagrams

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: A DØ type card is required for BMAP, QMAP, MULTIMAP, MØDMAP, ØVMAP, ØVMULTIMAP, or TABMAP printing or STAT table generation. Any or all of these diagrams may be printed from one DØ type card. The name field for a DØ type card must be the name of the site under consideration for diagram production or the UTM grid zone designator for keyword GET.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
CHAR	1-4		N.A.	T.4.MAIN-I VOL.IID	Four character alphanumeric characters to be used for ØVØRMAP and ØVPMULTIMAP plots. Up to 16 characters (4 for each parameter) may be changed.
SAVE	0-149		N.A.	T.4.MAIN-I VOL.IID	Specifies the Critical Altitude Function generated from the DMF tape is to be added to the CAF tape. No parameters.

operator type, the conditions under which the card is (or is not) read, the keyword names valid for this operator, the number of parameters allowed for this keyword, the parameters allowed by parameter position, the parameter range and description. The column for interaction contains the page number where the interaction is described. Finally, notes on card and variable usage are included.

T.2.4 TERAIN Submodels

TERAIN utilizes the following five submodels: Terrain Data Collation, Critical Altitude Function Generation, Critical Altitude Function Recording, Statistics Generation, and Coverage Diagram Generation.

T.2.4.1 NAME: Terrain Data Collation

T.2.4.1.1 Input Keywords Affecting This Submodel: None

T.2.4.1.2 Other Submodels Affecting This Submodel:
FRAG1A - Area Map Allocation

T.2.4.1.3 Algorithm Description:

The collation process consists of determining a list of terrain records whose boundaries overlap the area map under consideration. The required records are then read from mass storage, one by one, and stored in an input buffer. The map boundaries and record boundaries are used to determine what part of the record will be transferred into the main map array. Each record part is then stored in the main map array and the process continues until all required data are stored.

T.2.4.1.4 Alternate Algorithms: None

T.2.4.1.5 Examples of Inputs and Their Effects: None

T.2.4.2 NAME: Critical Altitude Function Generation

T.2.4.2.1 Input Keywords Affecting This Submodel: None

T.2.4.2.2 Other Submodels Affecting This Submodel:

FRAG1A-DMF Generation
FRAG1A-DMF Recording

T.2.4.2.3 Algorithm Description:

Once the terrain data have been stored in central memory for the area map for which the critical altitude function is to be generated, the critical altitude is determined for each terrain sample point on that map. The procedure is: first, determine the range and azimuth of the point, relative to the site location. Then, the two closest radials which have dominant masks recorded for them are identified. The tangent of the mask angle is identified for this point's range along both of these radials These two radial tangents are then linearly interpolated between to determine the dominant mask for the point under consideration. The point range and mask angle tangents are used to calculate the differential altitude between this point and the site altitude. The difference between the terrain elevation of the site and the terrain elevation of the point under consideration are then added to the differential mask altitude in order to get the critical altitude for this point. This process is repeated until the critical altitudes have been determined for all (40804) points on the (100.5 x 100.5 km) map and the CAF is then stored in a CAF array.

T.2.4.2.4 Alternate Algorithms: None

T.2.4.2.5 Examples of Inputs and Their Effects: None

T.2.4.3 NAME: Critical Altitude Function Recording

T.2.4.3.1 Input Keywords Affecting This Submodel:

The keyword SAVE causes CAF's to be recorded.

T.2.4.3.2 Other Submodels Affecting This Submodel: None

T.2.4.3.3 Algorithm Description:

The Critical Altitude Function is recorded in a series of 1717 word logical records. The first logical record contains the site data, map header data and the CAF data starting at word number 79.

T.2.4.3.4 Alternate Algorithms: None

T.2.4.3.5 Examples of Inputs and Their Effects:

If the CAF has not been marked for recording by entry of keyword SAVE or the site was not on a MULT type card, this site CAF will not be recorded.

T.2.4.4 NAME: Statistics Generation

T.2.4.4.1 Input Keywords Affecting This Submodel:

Statistics will only be calculated for sites which have the keyword STAT specified on their DØ type cards.

T.2.4.4.2 Other Submodels Affecting This Submodel: None

T.2.4.4.3 Algorithm Description:

TERAIN first sections the airspace surrounding the site into pie shaped sections and curvilinear cubes for which a point count will be kept for each cube. The CAF points are then accessed, one by one, and volume indices corresponding to the volume section in which this point lies are incremented. This continues until all the CAF points have been categorized by azimuth sector, altitude bracket and range bracket. A table of point counts and count percentages are then printed.

T.2.4.4.4 Alternate Algorithms: None

T.2.4.4.5 Examples of Inputs and Their Effects:

The parameters entered for the keyword STAT specify range brackets, azimuth sections and altitude brackets. The number and size of these brackets change the size of the volumes and the granularity of the statistics generated.

T.2.4.5 NAME: Coverage Diagram Generation

T.2.4.5.1 Input Keywords Affecting This Submodel:

BMAP, QMAP, MULTIMAP, MØDMAP, ØVMAP, ØVMULTIMAP, ANDMAP, ØRMAP, OVPORMAP all specify different types of diagrams to be generated.

T.2.4.5.2 Other Submodels Affecting This Submodel: None

T.2.4.5.3 Algorithm Description:

Coverage diagrams are generated by TERAIN for specified areas of interest. First, the legend is printed for the type of diagram to be printed. This legend will consist of the character/quantization interval correspondence for quantized type diagrams, character/"Boolean" altitude indicator (visible or not visible) correspondence for Boolean type diagrams, or the characters/altitudes correspondence if overprint is to be used. Next, the map points are then accessed line by line and the characters corresponding to the quantization interval in which the point lies (quantized diagram) or corresponding to the "Boolean" altitude indicator (Boolean diagram) are loaded into the first line buffer. If the diagram is being overprinted, the characters from the overprint legend, corresponding to these point altitudes are then loaded into the overprint buffers. The line is then printed and the process continues until the total diagram has been printed.

T.2.4.5.4 Alternate Algorithms: None

T.2.4.5.5 Examples of Inputs and Their Effects: None

T.2.5 Input Conventions

T.2.5.1 General

The following conventions are used within the TACOS II input descriptions.

CHARACTERS	CONVENTION
Letters - o	Ø
I	I
Numbers - 0	0
1	1
Blank - (space)	ƀ

LOGIC

Implication (ØRDER)	→

For example: 'SITE' → Site sort

Explicit characters to be input in prescribed data fields appear within single quotation marks; e.g., 'ƀTRR'.

T.2.5.2 FORTRAN Codes

The general FORTRAN input format codes are:

aIw	Integer data fields.
aFw.d	Real (floating point) data field.
aEw.d	Real (floating point) data field.
aAw	Octal data field.
aLw	Logical data field.
aAw	Alphanumeric data field.
wX	Indicates that a field is to be skipped.
a(...)	Indicates a group format specification.

where: a is optional and is an unsigned integer constant used to denote the number of times the format code is to be used. If a omitted, the code is used only once.

w is an unsigned integer constant specifying the number of characters of data in the field.

d is an unsigned integer constant specifying the number of characters of data in the field.

(...) within the parentheses are format codes separated by commas. The a preceding this form is the group repeat count.

T.2.5.2.1 Integer Data Field Notes

Do not use special or alphabetic characters; i.e., letters A to Z, periods (.), slashes (/), @, decimal point, etc.

A blank field is considered to be zero; i.e., same as entering '0' in that field.

All data should be right justified within the field. If the data are not right justified within the field, the remaining fields to the right of the actual data will be filled with significant zeroes.

T.2.5.2.2 Real (Floating Point) Data Field Notes

A decimal point need not be provided in the data; however, the program will assume the decimal point is located as indicated in the format code; e.g., Format code F4.2 and input data right justified 199 will be interpreted as 1.99.

Do not use special or alphabetic characters; i.e., letters A to Z, $, @, etc. A decimal point (.) and a minus sign (-) are valid.

If a decimal point is to be input in a field, its position overrides the position indicated by the d portion of the format code and the positions reserved by w must include a place for the decimal point.

Leading, embedded, and trailing blanks in the field are interpreted as zeroes.

For very large numbers, the number can be input through the use of decimal exponents, i.e., powers of 10. This is done by following the desired significant figure (with the decimal point anywhere in the figures) with the letter "E" and the appropriate power of ten. For example:

1300000000000000000000.

may be written as

1.3E+21 or .13E+22 or 1.3E21.

.0000000000000000000009

may be written as

.9E-19 or 9.E-20

The exponent field is treated as an integer and must be right justified in the field; otherwise, trailing blanks are interpreted as zeroes.

T.2.5.2.3 Octal Data Field Notes

Octal digits have the following correspondence to decimal numbers:

0	1	2	3	4	5	6	7	10	11	12	Octal
0	1	2	3	4	5	6	7	8	9	10	Decimal

They are used to set random number bases or to serve through their internal binary representation as a series of on/off switches.

T.2.5.2.4 Logical Data Field Notes

They are used for input of logical decisions; TRUE or FALSE.

The first T or F encountered (reading left to right) in the logical data field causes a value of TRUE or FALSE, respectively.

All blanks in the field are interpreted as FALSE.

T.2.5.2.5 Alphanumeric Data Field Notes

Any alphabetic or numeric character may be used in this type of field.

Numbers may be used within this field and they are considered as characters.

All alphanumeric identifiers of entities and entity characteristic categories are arbitrary.

T.2.5.2.6 Special Characters

Special Characters used as field delimiters during TERAIN input are:

blank - Delimits name, operator and operand fields.

comma - Delimits keyword and parameter fields.

equals, left parenthesis - Delimits parameter fields.
and right parenthesis

T.3 RUN DECK SETUP

The MICOM version of TACOS II was designed to be run on a CDC 6600 with an operating system of Scope 3.4. This section describes the control cards to be used for a typical run. Also, examples of various combinations of input control cards are given.

T.3.1 Typical Control Card Setup

The data requirements and formats for TERAIN have been thoroughly discussed in previous sections. It remains only to show an example of a typical run which was made on the MICOM computer. This is shown in Figure T.3-1. All control and request cards are shown, as well the relative locations of FORTRAN and data decks. In order to show the reader what is required for compilation, the example is for both compile and run.

T.3.2 Input Data Deck Example

Figure T.3-2 shows an example TERAIN input data deck. As shown,

```
ACCT(PN=SHOLES,PBC=3603C19900,CC=3600,OP
=A3,JN=1092)
LIMIT,700.
REQUEST,OLDPL,HY.                   S05001
REWIND,OLDPL.
REQUEST,NEWPL,HY.                   SCRATCH,SA
VE
REWIND,NEWPL.
UPDATE(F,N=NEWPL)
UNLOAD,OLDPL.
REWIND(TAP13)
COPY(TAP13,TAPE13)
UNLOAD,TAP13.
REWIND,TAPE13.
REQUEST,TAPE10,HY.                  S02264
REWIND(TAPE10)
FTN(I=COMPILE)
LDSET(PRESET=ZERO)
LGO.
REWIND,NEWPL.
COPYBF(NEWPL,DUM)
COPYBF(LGO,NEWPL)
&
          •
          •
          •
   - FORTRAN DECK -
          •
          •
          •
&
&
          •
          •
          •
    - DATA DECK-
          •
          •
          •
&
#
```

Figure T.3-1. Sample TERAIN Deck Setup

```
COL                                                                  COL
 1                                                                   72

 SET PLOT(=N, LPP=65, NOLOAD), SCALE=11111
S522 DO  NMAP=100, OVMAP=10, ORMAP=100, MULTIMAP=(100,200,400)
S523 DO MULTIMAP=10                                                  -
 MULTI   ANDMAP=(100,NV20005800,0,0,S523,S524,S525),                 X
               ORMAP=(100,NV20005800,0,0,S523,S524,S525),            X
               OVORMAP=(100,NV20005600,0,0,S523,S524,S525)
```

Figure T.3-2. Example TERAIN Input Data Deck

the SET operator is used to initialize the printer scale and spacing. An area card is used to print a quantized (interval=10) map of the square shown by the GET keyword parameters. Next, a DØ operator is used to print coverage diagrams of site A023. First, two Boolean coverage diagrams will be generated for reference altitudes of 100 and 200 meters, respectively. A quantized radar coverage diagram with a reference altitude of 10 meters is then requested, followed by a request for an overprinted multireference Boolean radar coverage diagram. A MULT operator is then utilized to request a site count radar coverage diagram and a joint Boolean radar coverage diagram.

T.4 OUTPUT DATA DEFINITIONS

T.4.1 Output Report Sequencing

T.4.1.1 Flowchart

Figure T.4-1 is the Output Report Sequencing flowchart for TERAIN. The reflected input data are printed first, followed by an AREA type maps which might be specified. Coverage Diagrams are then printed in the sequence in which their CAF's are accessed, followed by any print for MULT type maps.

T.4.1.2 Coverage Diagram Types

T.4.1.2.1 Modular Radar Coverage Diagrams

A Modular Radar Coverage Diagram option actually generates two separate diagrams, one remainder and one quotient, for each quantization interval specified. The quotient diagram is a quantized radar coverage diagram with a quantization interval of 36 times the specified interval. The remainder diagram is a quantized diagram of the remainder left by the quotient diagram. The quantization interval for this diagram will be the specified interval. See Figure T.4-2.

T.4.1.2.2 Boolean Radar Coverage Diagrams

A Boolean Radar Coverage Diagram shows for all map points whether or not a vehicle at a specified altitude above local terrain would be visible to the input site. For example , a Boolean Radar Coverage Diagram might consist of the characters at points where the vehicle is visible and a blank at points where the vehicle is not visible. See Figure T.4-3.

T.4.1.2.3 Overprinted Modular Radar Coverage Diagrams

The Overprinted Modular Radar Coverage Diagram is an overprint of the two quantized radar coverage diagrams generated from a modular radar coverage diagram. See Figure T.4-4.

T.4.1.2.4 Quantized Radar Coverage Diagram

A Quantized Radar Coverage Diagram indicates the quantization level in which a vehicle would become visible to a specified site. After

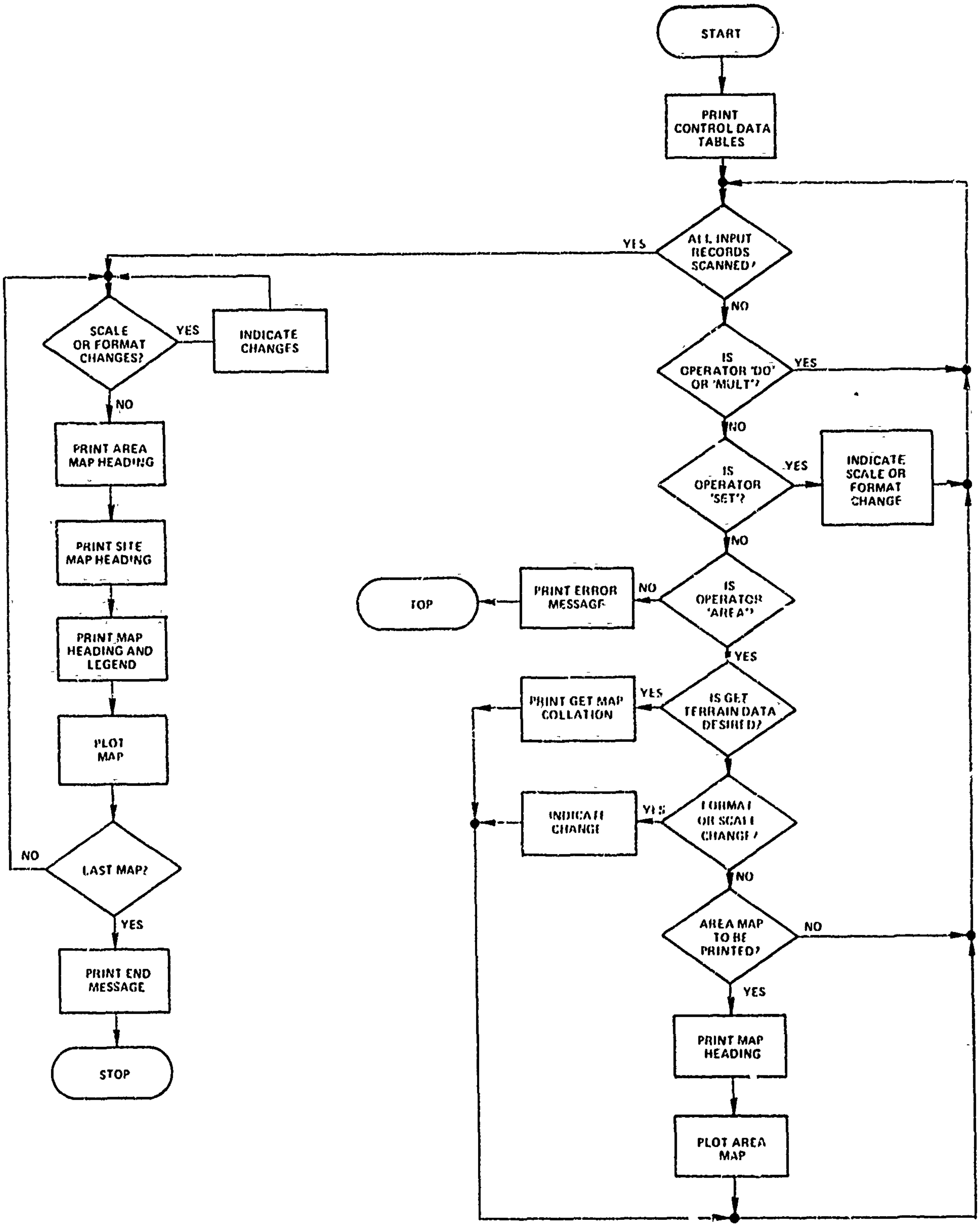


Figure T.4-1. TERAIN Output Report Sequencing Flowchart

```
USACDCADA MODULAR RADAR COVERAGE MAP
MAP AREA FROM NV22906680 TO PA 2904650 IN ZONE 32UF.  LATERAL RATE =  500.  VERTICAL RATE =  10. SCALE =11.111 KM/INCH
SITE SYXXS523, AT NA62900680,  388.0 METERS ABOVE S.L.  R=  40.0 RE =8490. IAL =-0. NRDL = 210  SECTOR =   0.0-360.0
*** LEGEND  ***
SITE LOCATION  <
QUANTIZATION INTERVAL    10
   0 TO   10     9   90 TO  100     I  180 TO  190     R  270 TO  280
1 10 TO   20     A  100 TO  110     J  190 TO  200     S  280 TO  290
2 20 TO   30     B  110 TO  120     K  200 TO  210     T  290 TO  300
3 30 TO   40     C  120 TO  130     L  210 TO  220     U  300 TO  310
4 40 TO   50     D  130 TO  140     M  220 TO  230     V  310 TO  320
5 50 TO   60     E  140 TO  150     N  230 TO  240     W  320 TO  330
6 60 TO   70     F  150 TO  160     O  240 TO  250     X  330 TO  340
7 70 TO   80     G  160 TO  170     P  250 TO  260     Y  340 TO  350
8 80 TO   90     H  170 TO  180     Q  260 TO  270     Z  350 TO  360
CODES ABOVE REFLECT VALUES MODULO      360.
```

Figure T.4-2. Example Modular Radar Coverage Map

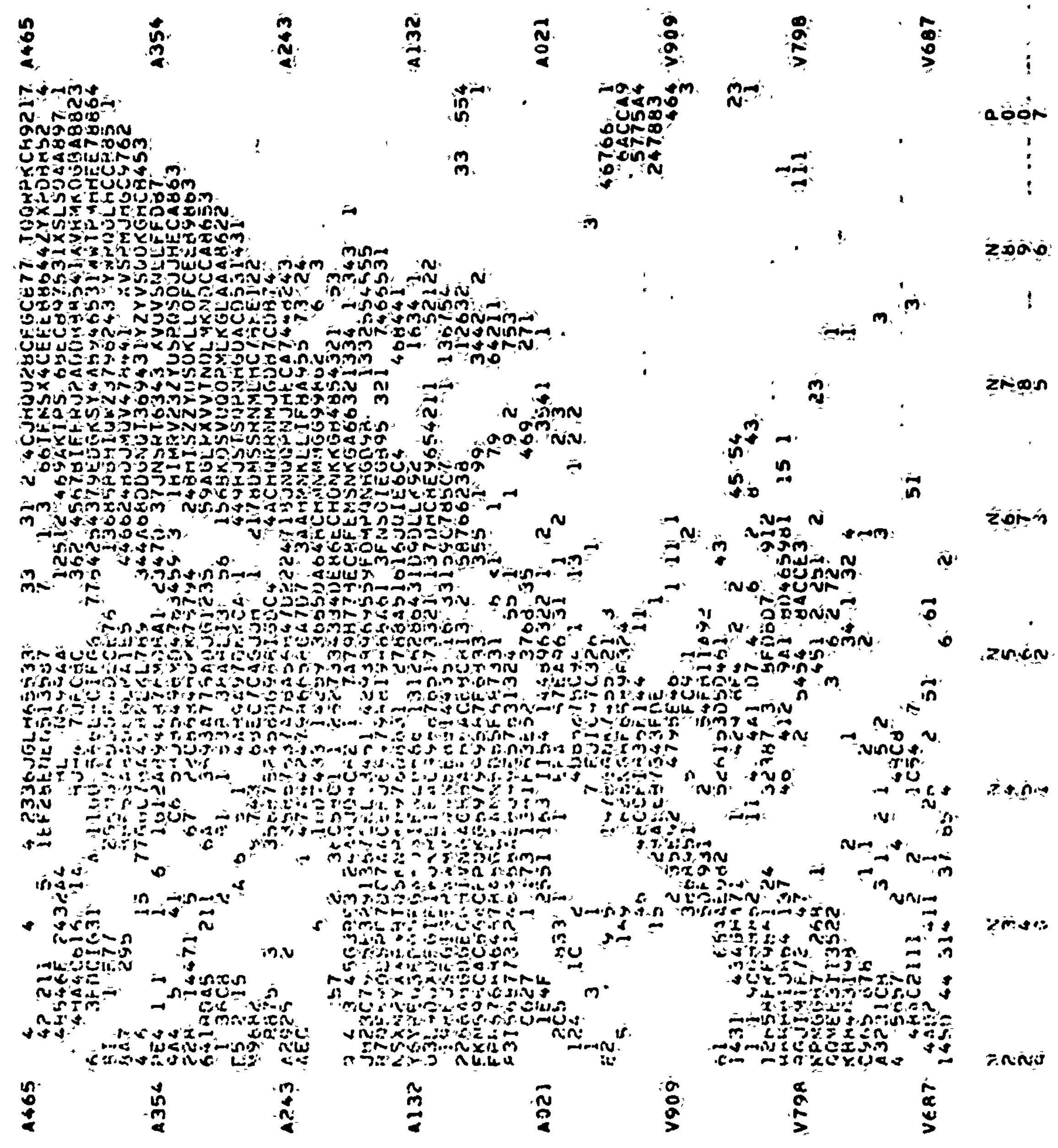
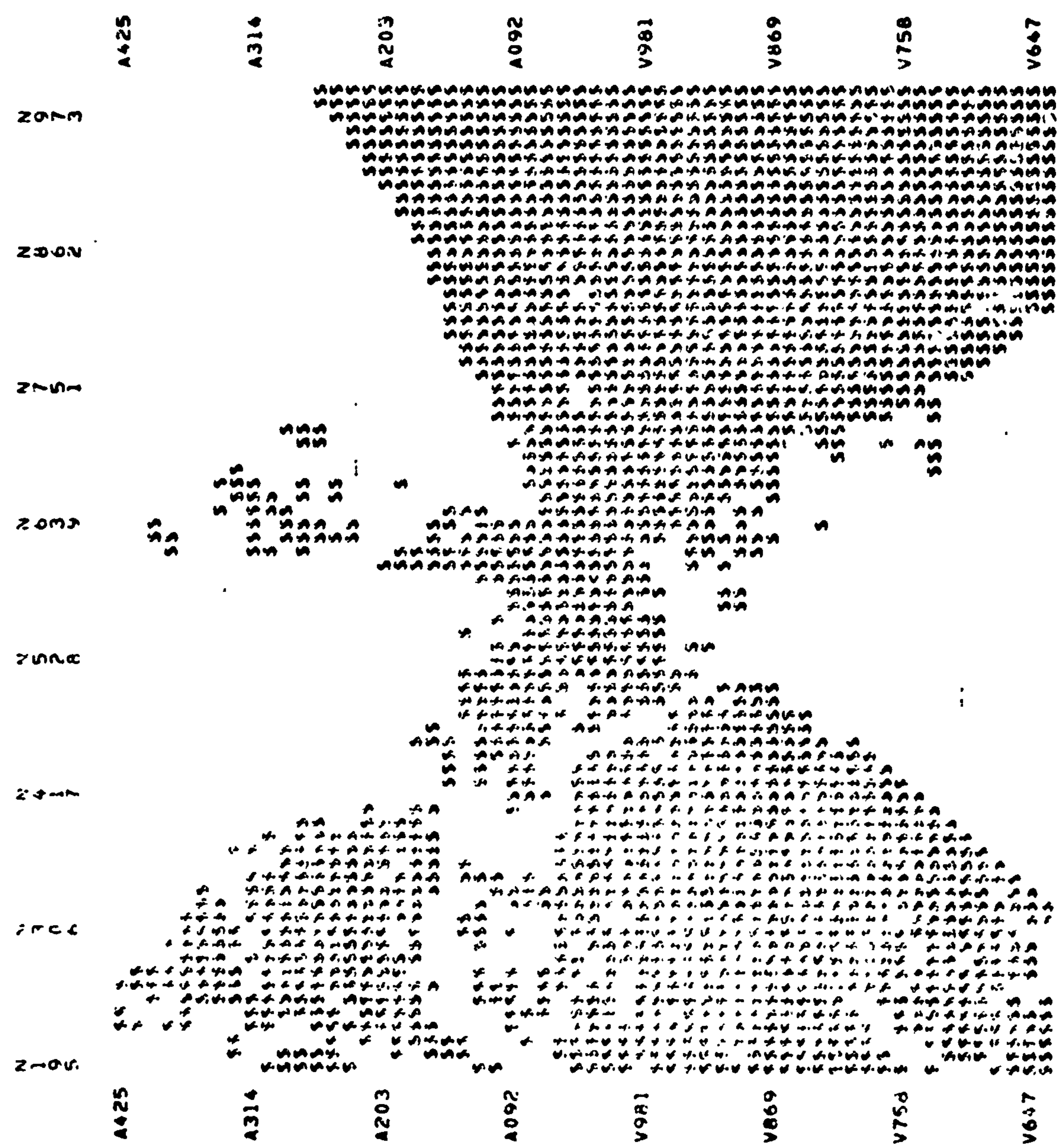


Figure T.4-2. Example Modular Radar Coverage Map (Continued)

```
USACDCADA BOOLEAN RADAR COVERAGE MAP
MAP AREA FROM NV19506250 TO NA99504250 IN ZONE 32UF.  LATERAL RATE =  500.  VERTICAL RATE =  10. SCALE =11.111 KM/INCH
SITE SYXX5525. AT NA59500250.  352.0 METERS ABOVE S.L.  R=  40.0 RE =8490. IAL =-0. NRDL = 210. SECTOR =   0.0-360.0
*** LEGEND ***
SITE LOCATION  <
VISIBLE=S.  INVISIBLE=BLANK
REFERENCE ALTITUDE =  100 METERS ABOVE LOCAL TERRAIN
```

Figure T.4-3.   Example Boolean Radar Coverage Diagram



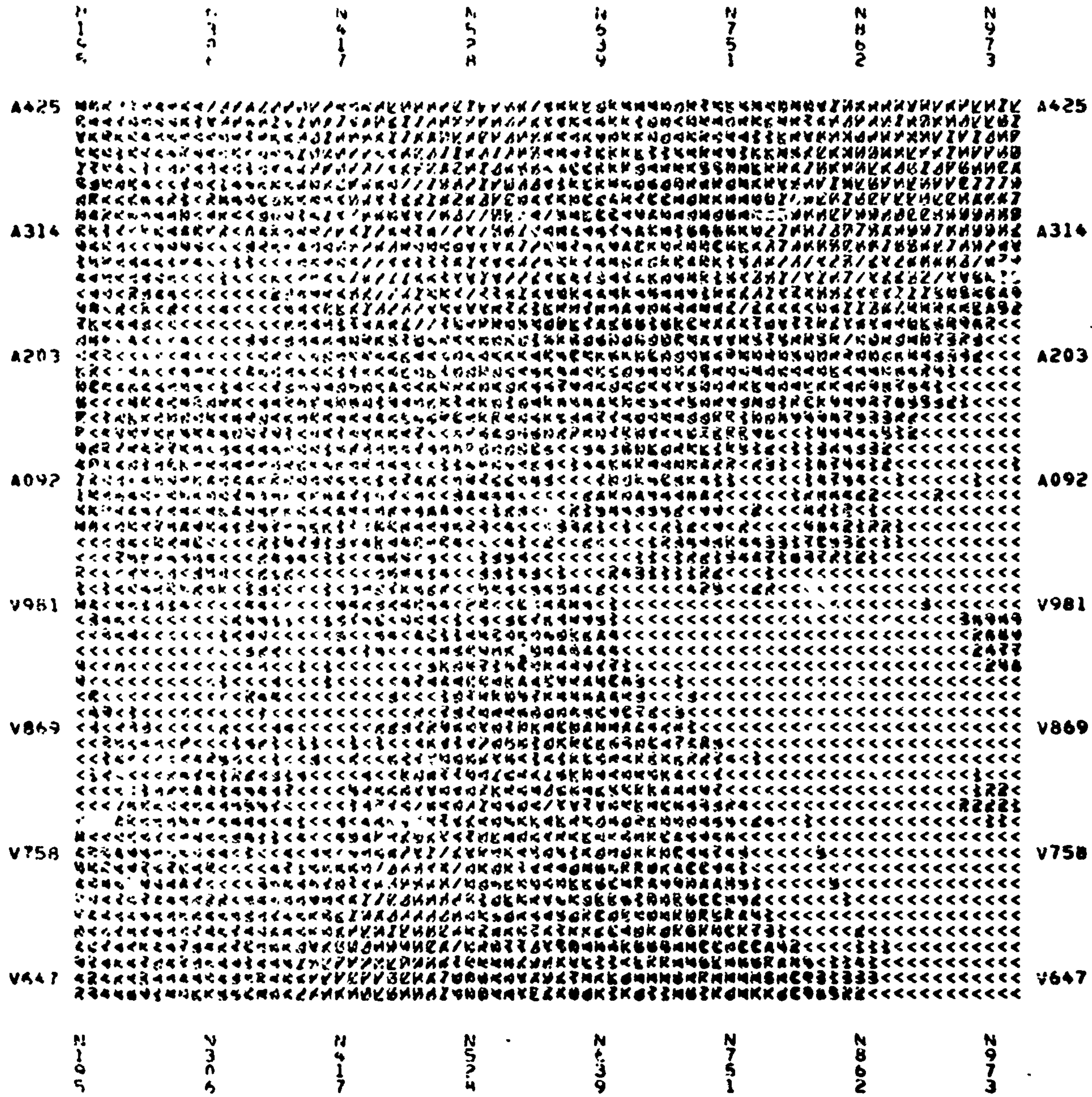
TIME= 54.97 TINT= 10.72

REQUESTED ACTION COMPLETED

Figure T.4-3. Example Boolean Radar Coverage Diagram (Continued)

```
USACDCADA MODULAR RADAR COVERAGE MAP
MAP AREA FROM NV19505250 TO NA49504250 IN ZONE 32UF.  LATERAL RATE =  500.  VERTICAL RATE =  10. SCALE =11.111 KM/INCH
SITE S'AAS5525. AT NA59500250.  352.0 METERS ABOVE S.L.  H=  40.0 RE =8490. IAL =-0. NRDL = 210. SECTOR =   0.0-360.0
*** LEGEND ***
SITE LOCATION  <
      0 TO   10     9    90 TO 100    I   180 TO 190    R   270 TO 280
1    10 TO   20     A   100 TO 110    J   190 TO 200    S   280 TO 290
2    20 TO   30     B   110 TO 120    K   200 TO 210    T   290 TO 300
3    30 TO   40     C   120 TO 130    L   210 TO 220    U   300 TO 310
4    40 TO   50     D   130 TO 140    M   220 TO 230    V   310 TO 320
5    50 TO   60     E   140 TO 150    N   230 TO 240    W   320 TO 330
6    60 TO   70     F   150 TO 160    O   240 TO 250    X   330 TO 340
7    70 TO   80     G   160 TO 170    P   250 TO 260    Y   340 TO 350
8    80 TO   90     H   170 TO 180    Q   260 TO 270    Z   350 TO 360
ALL VALUES GREATER THAN   360 ARE REPRESENTED BY Z.
OVERPRINT LEGEND
        0 TO   360
/     360 TO   720
=     720 TO  1080
)    1080 TO  1440
+    1440 TO  1800
(    1800 TO  2160
-    2160 TO  2520
-    2520 TO  2880
.    2880 TO  3240
*    3240 TO  3600
$    3600 TO  3960
```

Figure T.4-4. Example Modular Radar Coverage Diagram



REQUESTED ACTION COMPLETED TIME= 56.00 TINT= 1.03

Figure T.4-4. Example Modular Radar Coverage Diagram (Continued)

the analyst specifies the quantization interval for a diagram, a character is assigned to each quantization level. For each point the altitude to which a vehicle must climb above local terrain to become visible is determined and the appropriate quantization character determined for that point. Any altitudes greater than 36 times the quantization interval will be shown as being in level 36. See Figure T.4-5.

T.4.1.2.5 Multireference Boolean Radar Coverage Diagrams

A Multireference Boolean Diagram allows the analyst to perform a Boolean type function at several reference altitudes. See Figure T.4-6.

T.4.1 2.6 Site Count Radar Coverage Diagrams

A Site Count Radar Coverage Diagram provides a count of the number of sites which can see a point at a specified reference altitude for the area of interest. This diagram provides no information about which sites can see the point under consideration, only the number of sites. See Figure T.4-7.

T.4.1.2.7 Joint Boolean Radar Coverage Diagrams

A Joint Boolean Radar Coverage Diagram shows which sites can see a point at a specified reference altitude for the area of interest. See Figure T.4-8.

T.4.1.2.8 Map Overprint

Multireference Boolean, Modular, and Joint Boolean Diagrams may be displayed more effectively by using overprinted characters. Thus, by proper character selection, diagrams may be shaded for identification of topography. Figure T.4-9 is the same CA, as shown in Figure T.4-5, only overprinted.

T.4.1.2.9 Tabular Maps

Tabular maps are used to print the digital terrain or CAF representations from central memory. These maps are utilized by analyst for pictorial data display and planning.

USACDCADA QUANTIZED FUNCTION RADAR COVERAGE MAP

MAP AREA FROM NV15506250 TO NA99504250 IN ZONE 32UF. LATERAL RATE = 500. VERTICAL RATE = 10. SCALE =11.111 KM/INCH

SITE SYXA5525. AT NA59506250. 352.0 METERS ABOVE S.L. H= 40.0 RE =8490. IAL =-0. NRDL = 210. SECTOR = 0.0-360.0

*** LEGEND ***

SITE LOCATION <

QUANTIZATION INTERVAL = 100

	0 TO	100	9	900 TO	1000	I	1800 TO	1900	R	2700 TO	2800
1	100 TO	200	A	1000 TO	1100	J	1900 TO	2000	S	2800 TO	2900
2	200 TO	300	B	1100 TO	1200	K	2000 TO	2100	T	2900 TO	3000
3	300 TO	400	C	1200 TO	1300	L	2100 TO	2200	U	3000 TO	3100
4	400 TO	500	D	1300 TO	1400	M	2200 TO	2300	V	3100 TO	3200
5	500 TO	600	E	1400 TO	1500	N	2300 TO	2400	W	3200 TO	3300
6	600 TO	700	F	1500 TO	1600	O	2400 TO	2500	X	3300 TO	3400
7	700 TO	800	G	1600 TO	1700	P	2500 TO	2600	Y	[illegible] TO	3500
8	800 TO	900	H	1700 TO	1800	Q	2600 TO	2700	Z	3500 TO	3600

ALL VALUES GREATER THAN 3600 ARE REPRESENTED BY Z.

Figure T.4-5. Example Quantized Function Radar Coverage Map

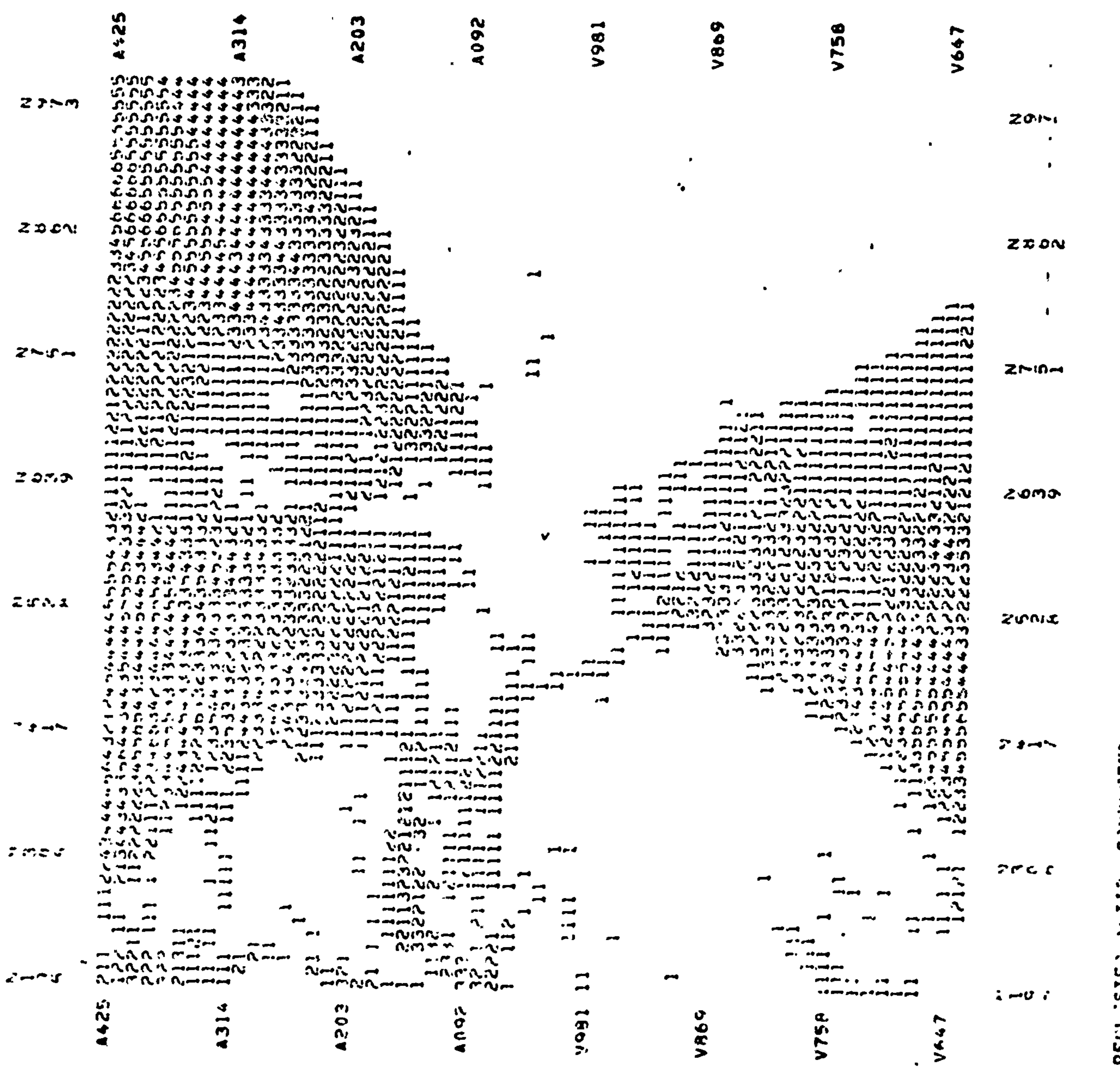
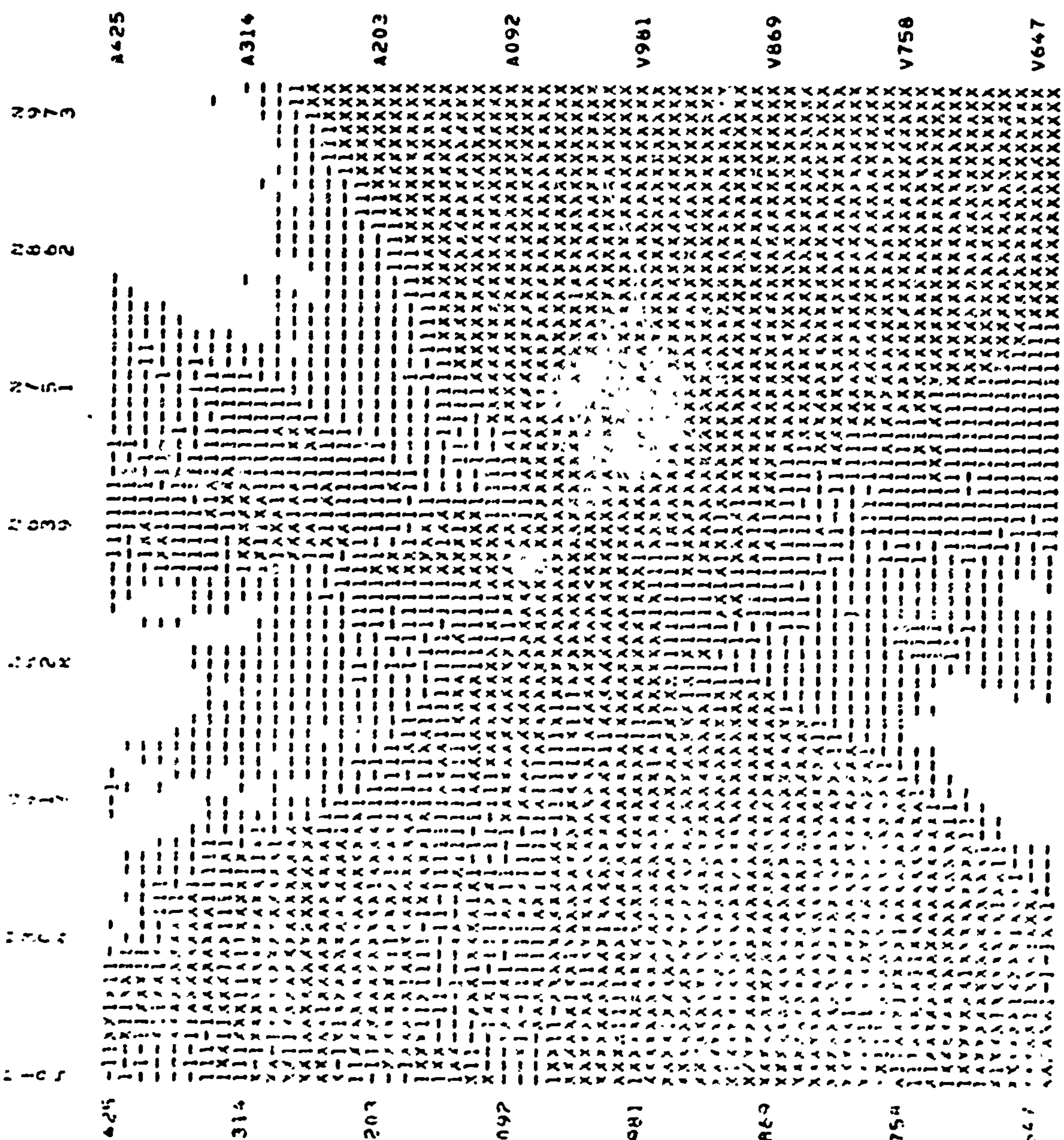


Figure T.4-5. Example Quantized Function Radar Coverage Map (Continued)

```
USACDCADA MULTIREFERENCE BOOLEAN RADAR COVERAGE MAP
MAP AREA FROM NV19506250 TO NA49504250 IN ZONE 32UF.  LATERAL RATE =  500.  VERTICAL RATE =  10. SCALE =11.111 KM/INCH
SITE SYA45525. AT NA59500250.  352.0 METERS ABOVE S.L.  R=  40.0 RE =8490. IAL =-0. NRDL = 210. SECTOR =   0.0-360.0
*** LEGEND  ***
SITE LOCATION  <
BLANK   INVISIBLE AT  400 METERS AND BELOW
  -     VISIBLE AT  400 METERS AND ABOVE
  I     VISIBLE AT  200 METERS AND ABOVE
  X     VISIBLE AT  100 METERS AND ABOVE.
```

Figure T.4-6.   Example Multireference Boolean Radar Coverage Map



TIME= 57.87 TINT= .97

REQUESTED ACTION COMPLETED
END OF DMA TAPE READ

Figure T.4-6. Example Multireference Boolean Radar Coverage Map (Continued)

USACDCADA SITE COUNT RADAR COVERAGE MAP

MAP.S-0000 [illegible] (NV20005800, PA20005800), (500, 1000) 200 TYPE = 3 FIX = T 200 201
[illegible] 100000.0 100000.0 420000.0 358700.0 500.0 10.0 .0200

MAP AREA FROM NV20005800 TO PA20005800 IN ZONE 32UF. LATERAL RATE = 500. VERTICAL RATE = 10. SCALE =11.111 KM/INCH

[illegible] LEGEND [illegible]

SITE LOCATION <

	0 TO	1	9	9 TO	10	I	18 TO	19	R	27 TO	28
1	1 TO	2	A	10 TO	11	J	19 TO	20	S	28 TO	29
2	2 TO	3	B	11 TO	12	K	20 TO	21	T	29 TO	30
3	3 TO	4	C	12 TO	13	L	21 TO	22	U	30 TO	31
4	4 TO	5	D	13 TO	14	M	22 TO	23	V	31 TO	32
5	5 TO	6	E	14 TO	15	N	23 TO	24	W	32 TO	33
6	6 TO	7	F	15 TO	16	O	24 TO	25	X	33 TO	34
7	7 TO	8	G	16 TO	17	P	25 TO	26	Y	34 TO	35
8	8 TO	9	H	17 TO	18	Q	26 TO	27	Z	35 TO	36

SEQ#	SITE	LOCATION	ALT	SECTOR	RANGE	NRDL
1	STAX5523	NA62900650	388.	0.0-360.0	40.0	210
2	STAX5524	NV6180[illegible]800	306.	0.0-360.0	40.0	210
3	STAX5525	NA59500250	352.	0.0-360.0	40.0	210

REFERENCE ALTITUDE = 100 METERS ABOVE LOCAL TERRAIN

Figure T.4-7. Example Site Count Radar Coverage Diagram

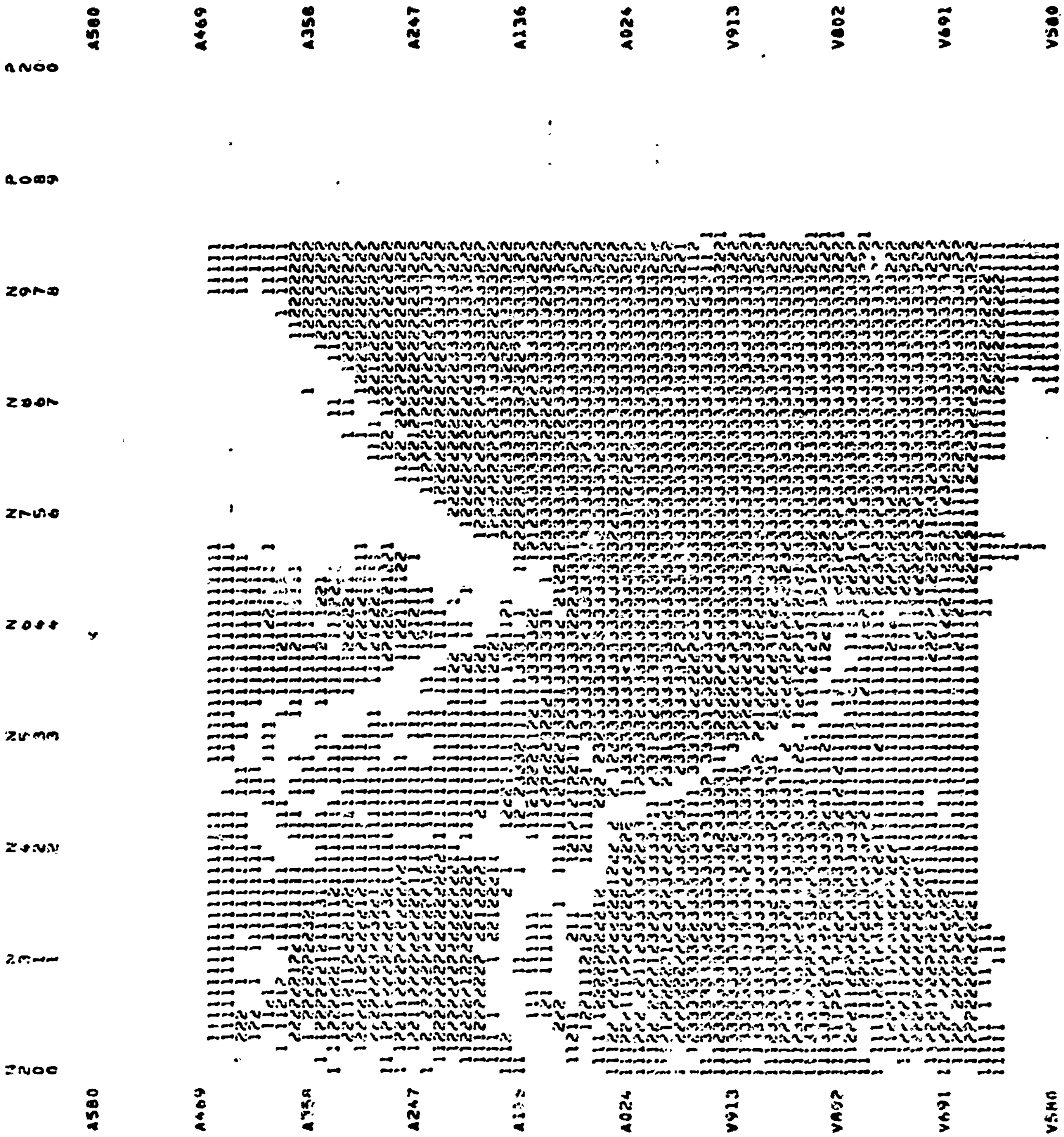


Figure T.4-7. Example Site Count Radar Coverage Diagram (Continued)

```
USACDCADA JOINT BOOLEAN COVERAGE MAP
MAP.(        ).(32UF).(NV20005800.PA20005800).( 500.1000). TYPE =** FIX = T
   320000     258000     100000     100000       200        200        201        201
  320000.0  258000.0  100000.0  100000.0  420000.0  358000.0     500.0      10.0     .0200
        MAP AREA FROM NV20005800 TO PA20005800 IN ZONE 32UF.  LATERAL RATE =  500.  VERTICAL RATE =  10. SCALE =11.111 KM/INCH
        *** LEGEND  ***
        SITE LOCATION  <
```

CODE	VISIBLE FROM SITE 1	2	3	4
0	F	F	F	F
1	T	F	F	F
2	F	T	F	F
3	T	T	F	F
4	F	F	T	F
5	T	F	T	F
6	F	T	T	F
7	T	T	T	F
A	F	F	F	T
B	T	F	F	T
C	F	T	F	T
D	T	T	F	T
E	F	F	T	T
F	T	F	T	T
G	F	T	T	T
H	T	T	T	T

SEQ*	SITE	LOCATION	ALT	SECTOR	RANGE	NRDL
1	SYXXS523	NA62900680	388.	0.0-360.0	40.0	210
2	SYXXS524	NV63H09800	306.	0..-360.0	40.0	210
3	SYXXS525	NA59500250	352.	0.0-360.0	40.0	210

REFERENCE ALTITUDE = 100 METERS ABOVE LOCAL TERRAIN

Figure T.4-8.   Joint Boolean Radar Coverage Diagram

122<

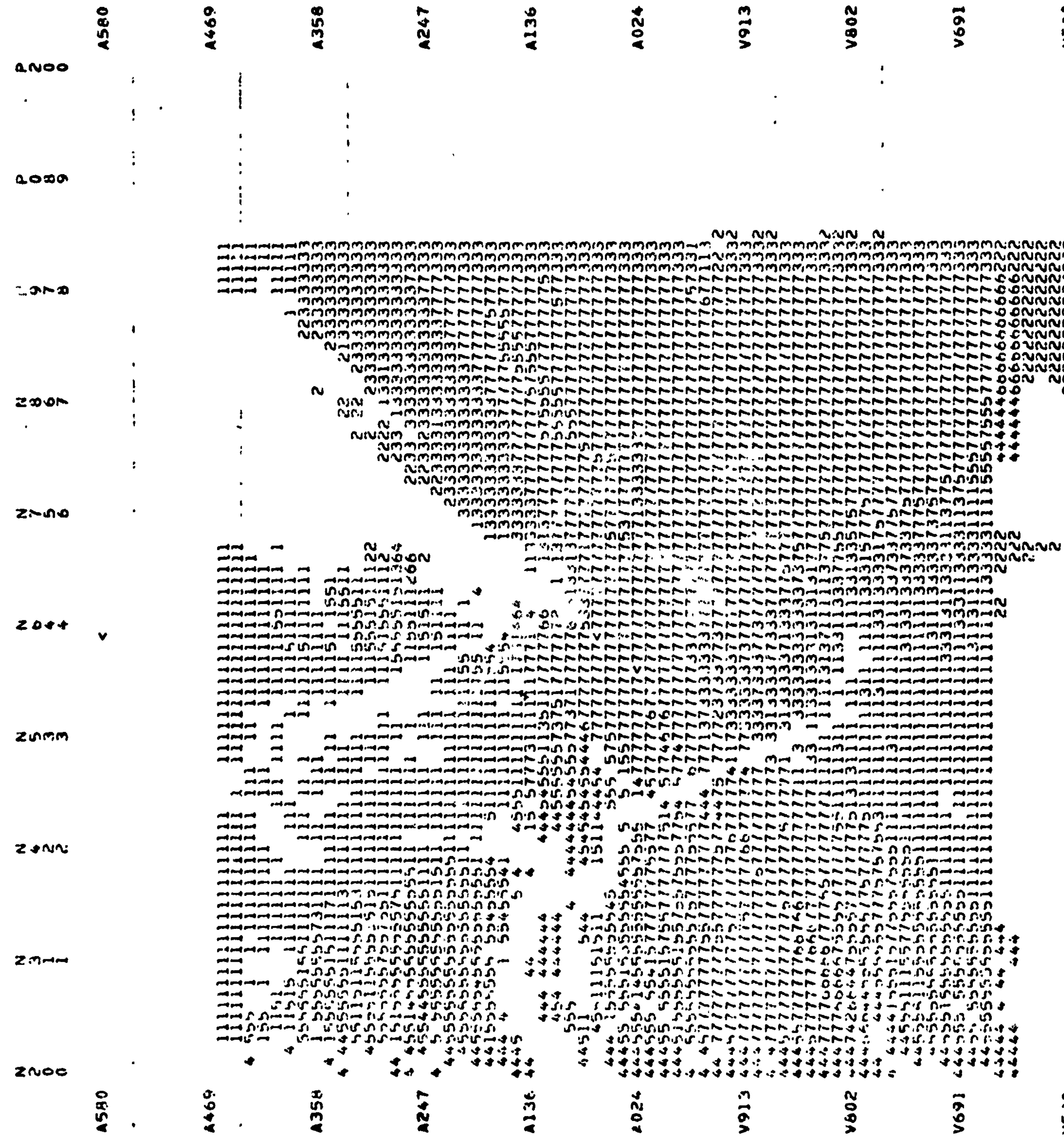


Figure T.4-8. Joint Boolean Radar Coverage Diagram (Continued)

```
USACOCADA JOINT BOOLEAN COVERAGE MAP
MAP.(         ).(32UF).(NV20005800.PA20005800).( 500.1000). TYPE *** FIX = T
   320000     258000     100000     100000      200        200        201        201
  320000.0  258000.0  100000.0  100000.0  420000.0  358000.0      500.0       10.0      .0200
MAP AREA FROM NV20005800 TO PA20005800 IN ZONE 32UF.  LATERAL RATE =  500.  VERTICAL RATE =  10. SCALE =11.111 KM/INCH
*** LEGEND  ***
SITE LOCATION  <
          VISIBLE FROM SITE
CODE        1 -:  2 1:  3 X:  4 O:

 SEQ#     SITE      LOCATION     ALT      SECTOR      RANGE    NRDL
  1     SYXX5523  NA62900680    388.    0.0-360.0     40.0     210
  2     SYXX5524  NV63809800    306.    0.0-360.0     40.0     210
  3     SYXX5525  NA59500250    352.    0.0-360.0     40.0     210
REFERENCE ALTITUDE =  100 METERS ABOVE LOCAL TERRAIN
```

Figure T.4-9.   Example of Overprinted Joint Boolean Coverage Map

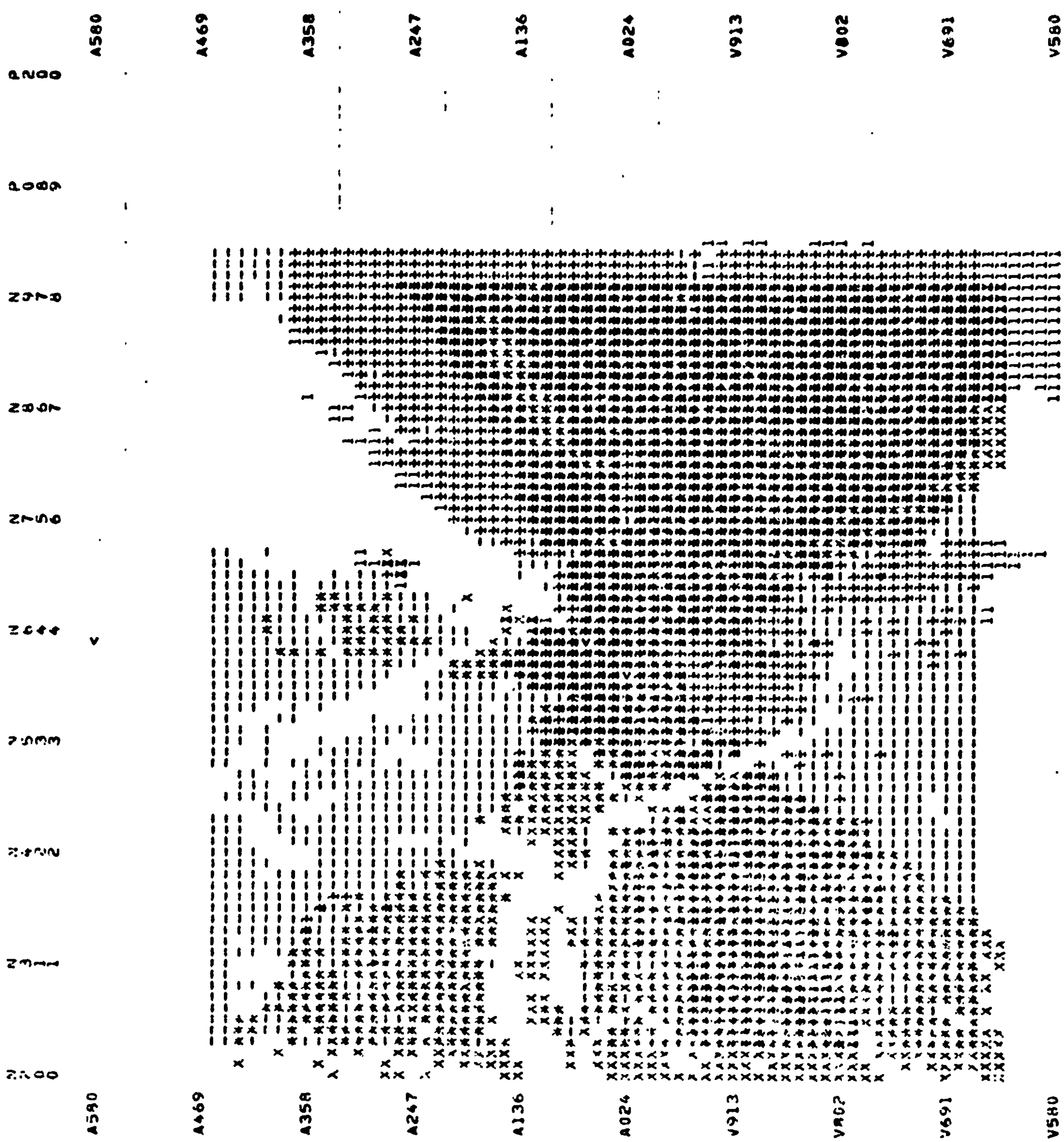


Figure T.4-9. Example of Overprinted Joint Boolean Coverage Map (Continued)

T.4.2 Annotated Output Report

T.4.2.1 Output Types

Figures T.4-10 through T.4-12 are annotated output reports from a typical TERAIN run. The reports consist of a reflected input data report, map headings, and a Coverage Diagram Report.

T.4.2.2 Reflected Input Data Report

Upon program initialization, a reflection of the input data deck is printed. The card format and order are preserved for this printout so that this may be used for error detection. Following this report, indicators are printed to inform the analyst that the action requested on the 'SET' type data card has been completed. See Figure T.4-10.

T.4.2.3 Map Headings

Prior to coverage diagram production, the area map heading for the area map containing the site under consideration, and the rescaled area map containing the site CAF, are printed. Both headings contain the area map location, dimensions, type, and data rates. See Figure T.4-11.

T.4.2.4 Coverage Diagram Report

Each Coverage Diagram Report consists of a heading, a legend, and a coverage diagram. The heading consists of a title indicating the type of diagram to be printed, map heading data, scale factor, and data describing the DMF used to generate this diagram. The legend contains a list of characters utilized in diagram printing and a definition of the significance of each. The actual diagram is a scaled character representation of the coverage diagram requested. See Figure T.4-12.

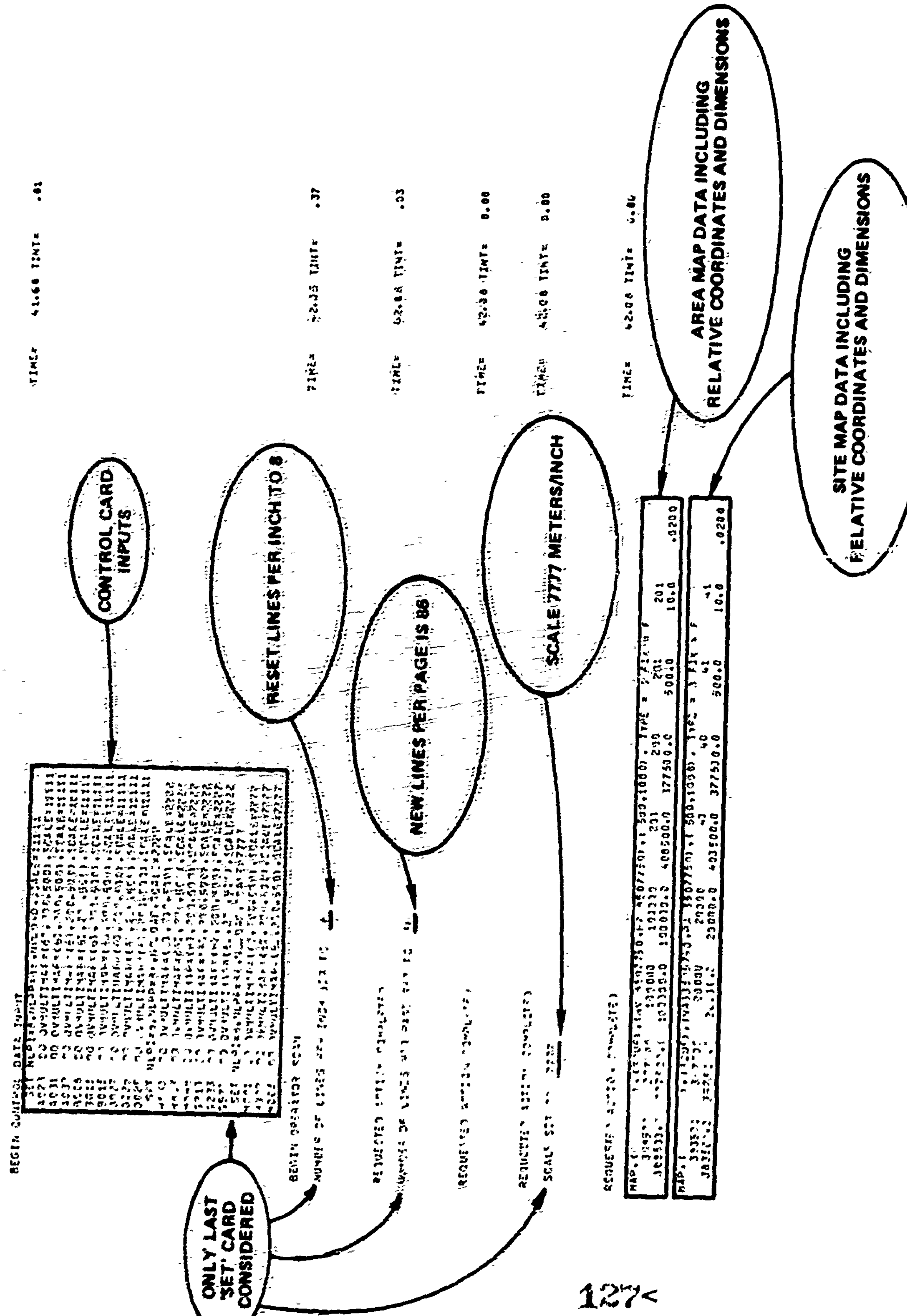


Figure T.4-10. Reflected Input Report

127<

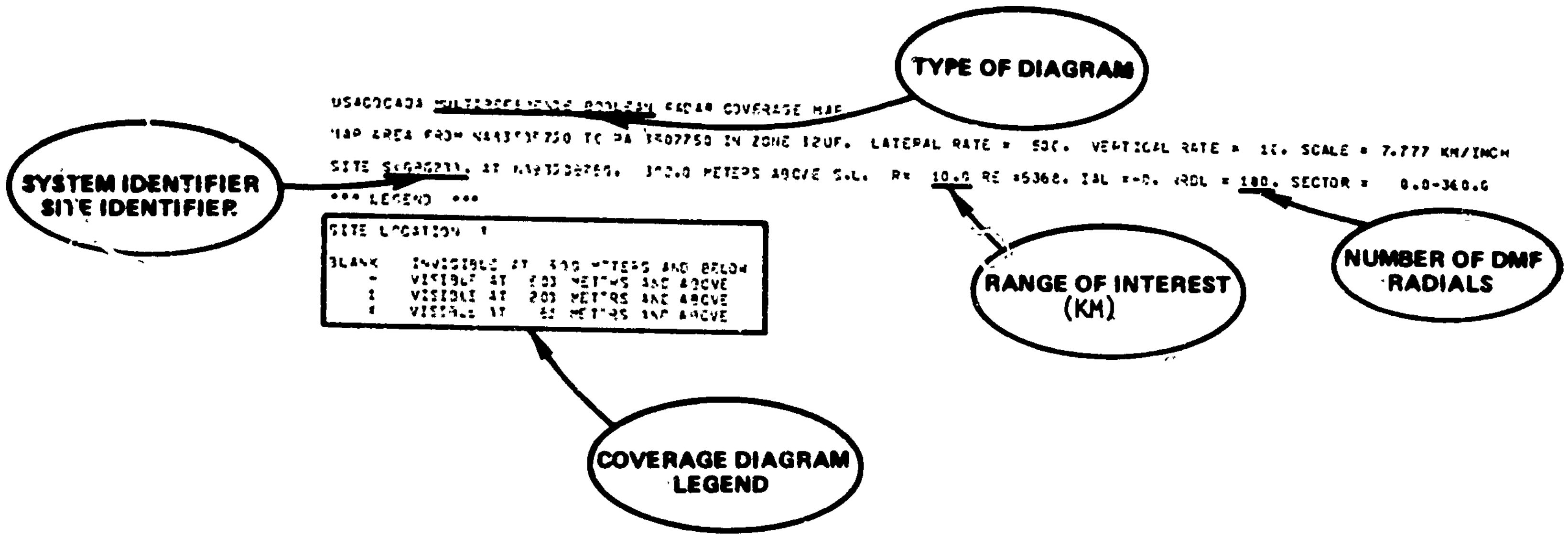


Figure T.4-11. Area Map Heading and Diagram Legend

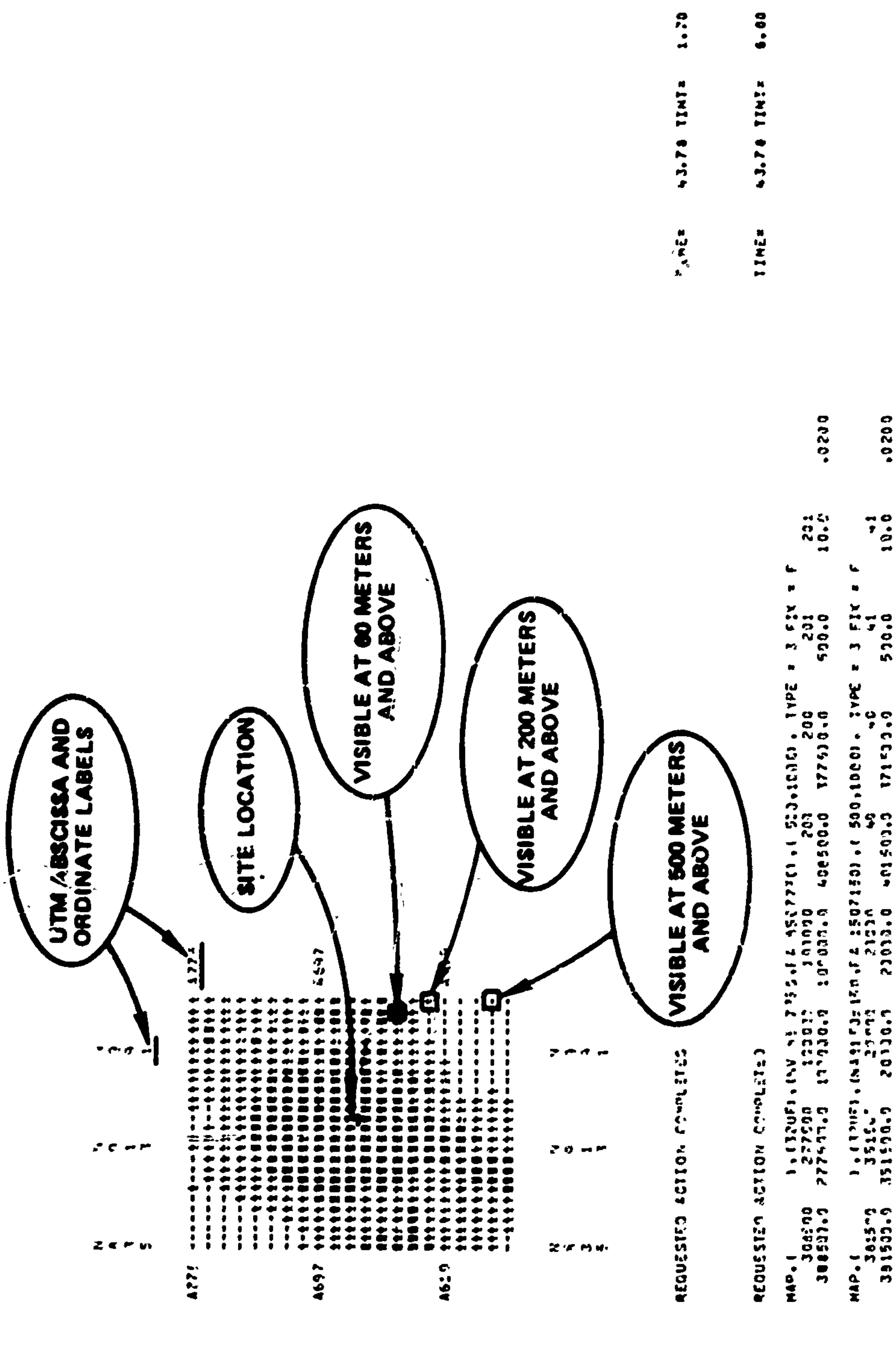


Figure T.4-12. Multireference Overprinted Boolean Radar Coverage Diagram

T.5 ERROR MESSAGE LIST

The following is an error message list for TERAIN. To facilitate error lookup, the errors are categorized by the subroutine name and the statement number in the subroutine where the error was detected. Error detection sometimes generates several messages providing a trace to the source of the error. For those errors that can usually be corrected by the analyst, the suggested corrective action is shown following the error or errors for which the corrective action applies.

ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
ABSCØR	1001	An illegal grid letter was returned by CNL.
	1700	The abscissa value extends beyond 132 spaces at the specified spacing.
CAF	1000	An error has occurred during calculation of area map limits, coordinate conversions,or in area map collation.
		- CORRECTIVE ACTION -
		Determine the site or sites causing this map to be generated. Either remove this (these) site(s) from the input, decrease the range(s) of interest,or move this (these) site(s) until the map lies within the first quadrant of the coordinate system.
CARDIN	0001	An embedded blank has been determined in the name field.
	0002	The required operator field is not on this card.
	0003	An embedded blank has been determined in the operator field.
	0004	The required keyword field is not on this card.
	0005	An embedded blank has been determined in the keyword field.
	0006	The required parameter field is not on this card.
	0007	An unspecified continuation has been encountered.
	0008	An unspecified continuation has been encountered.
	0009	An illegal delimiter has been encountered in the parameter field.
	0010	The numerical parameter field has not been properly closed with a closed parenthesis.
	0011	The alphameric parameter field has not been properly closed with a closed parenthesis.
	0012	An illegal character has been detected in the parameter field.
	0013	The parameter field has not been properly delimited with a close parenthesis.
	9998	An illegal keyword delimiter has been detected.
		- CORRECTIVE ACTION -
		Determine and correct the above mentioned format error. For further information on card format see section T.2.

ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
CML	1010	UTM coordinates of the southwest corner of the area map of interest is not convertible to relative easting and northing.
	1060	The relative easting and northing of the northeast corner of the area map of interest is not convertible to UTM. - CORRECTIVE ACTION - Refer to the corrective action suggested for CAF 1000.
CNVRT	9000	An out-of-position or illegal character has been detected.
DATA	1001	An unexpected end of card has been detected.
	1002	An illegal field has been determined on the input data card.
	1003	An illegal operator field has been detected.
	1004	An illegal keyword field has been detected.
	1007	An illegal field has been determined on the input data card. - CORRECTIVE ACTION - Refer to the corrective action suggested for CARDIN 9998.
FASCØL	1050	UTM coordinates of either the southwest or northeast corner of the desired area map is not convertible to relative easting and northing. - CORRECTIVE ACTION - Refer to the corrective action suggested for CAF 1000.
	1220	The grid zone specified does not match the grid zone from the accessible terrain file. - CORRECTIVE ACTION - Check the grid zone designator specified and the grid zone for the terrain file for correspondence. Select the grid zone designator which specifies the desired terrain data base.
	1250	One of the grid squares required for area map collation does not lie on the designated grid zone. - CORRECTIVE ACTION - Insure that the area map was properly specified and lies on available terrain.

ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
FASCØL (Cont'd)	1354	UTM coordinates of the southwest corner of required grid square is not convertible to relative easting and northing.
LABEL	1001	CNL cannot find a valid grid letter corresponding to the specified coordinate.
		- CORRECTIVE ACTION -
		Refer to the corrective action suggested for CAF 1000.
LØDCAF	1010	I/Ø parity error detected on file 12 during attempt to read CAF file.
	1030	An out-of-sequence EØF or an I/Ø parity error detected on file 12 during attempt to read CAF file.
MAIN	0014	I/Ø parity error encountered while reading DMF header from file 13.
		- CORRECTIVE ACTION -
		These errors occur during reading the CAF and DMF files. Parity errors can usually be corrected by standard "clean-up" techniques (such as cleaning the tape and read heads). Erroneous EØF's require a more detailed look at ways these might have been generated by the secondary input device. Improper tape mounting, improper tape deck operation, or machine failure should be checked.
	0015	Invalid grid zone designator read from the DMF file.
	0016	An error was encountered during calculation of coordinate system origin.
	0017	An error has been detected on an input data card.
	0019	An error was encountered in an attempt to load a DMF from file 12.
	0020	An error has been encountered during CAF generation or TABMAP printing.
	0023	An invalid keyword has been detected.
	0024	An error has been detected during CAF loading or statistics calculation.
	0025	An error has been detected during area map collation.
	0026	An illegal keyword has been determined.
	0027	The keyword stored is not valid for this operator field.
ØPER	XXXX	An illegal coordinate has been detected during coordinate conversion.

ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
ØPER (Cont'd)	1220	The UTM grid zone designator read from file 2 was not the specified designator. - CORRECTIVE ACTION - Insure that the map located on the CAF file and the specified grid zone origin correspond.
	1354	An illegal coordinate has been detected during square collatability testing.
PRTMAP	9000	An error was detected during generation of the required abscissa or ordinate labels.
STAT	1001	A conversion error has been detected by CITN during conversion of the site coordinates. - CORRECTIVE ACTION - Refer to the corrective action suggested for CAF 1000.
	1002	No altitude brackets were determined in the parameter array.
	1003	No range brackets were determined in the parameter array.
	1004	No azimuth sectors were determined in the parameter array. - CORRECTIVE ACTION - Correct the keyword parameters for keyword STAT on the DØ type input card.
TABMAP	1080	The abscissa value extends past 132 spaces at the specified spacing.
	1110	Generation of an illegal grid label has been detected. - CORRECTIVE ACTION - Refer to the corrective action for CAF 1000.
WØRD	9000	An illegal character has been detected in the field under consideration. - CORRECTIVE ACTION - Refer to the corrective action for CARDIN 9998

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CHAPTER P

PMAP USER/PLANNER GUIDE

P.1 DETAILED DESCRIPTION OF MODULE FUNCTION

PMAP is a CDC 6600 computer program used as a preliminary error detection program for the scenario input cards of the TACOS II model. In addition to format and sequence error detection, various optional features have been provided for the user's convenience. These include: plotting the sites and paths on a Universal Transverse Mercator (UTM) grid, identification of redundant sites, checking availability of terrain data for each site location, utilization of digitized terrain to evaluate input elevations, identification of paths which end within engagement range of a site, identification of targeted paths, identification of unusually long path segments, and the determination of those sites which, due to their location, and engagement range, can engage penetrators on at least one path.

Basically, PMAP reads the input site and path data perform specified data checks and plots the site locations on a site map and the path turn points for each path on separate path maps. The overall data flow for PMAP is illustrated in Figure P.1-1.

P.1.1 Submodels Used

PMAP utilizes the following five submodels: Site Data Checking, Path Data Checking, Targeted Path Identification, Path Engageability Identification, and Map Plotting.

P.1.1.1 Site Data Checking

As the site data are input to PMAP, they are checked for redundancies, such as duplicate site cards, sites with duplicate names and sites with identical locations. Each site is also checked to determine whether the site location lies on available terrain and whether the specified site altitude places this site beneath local terrain elevation.

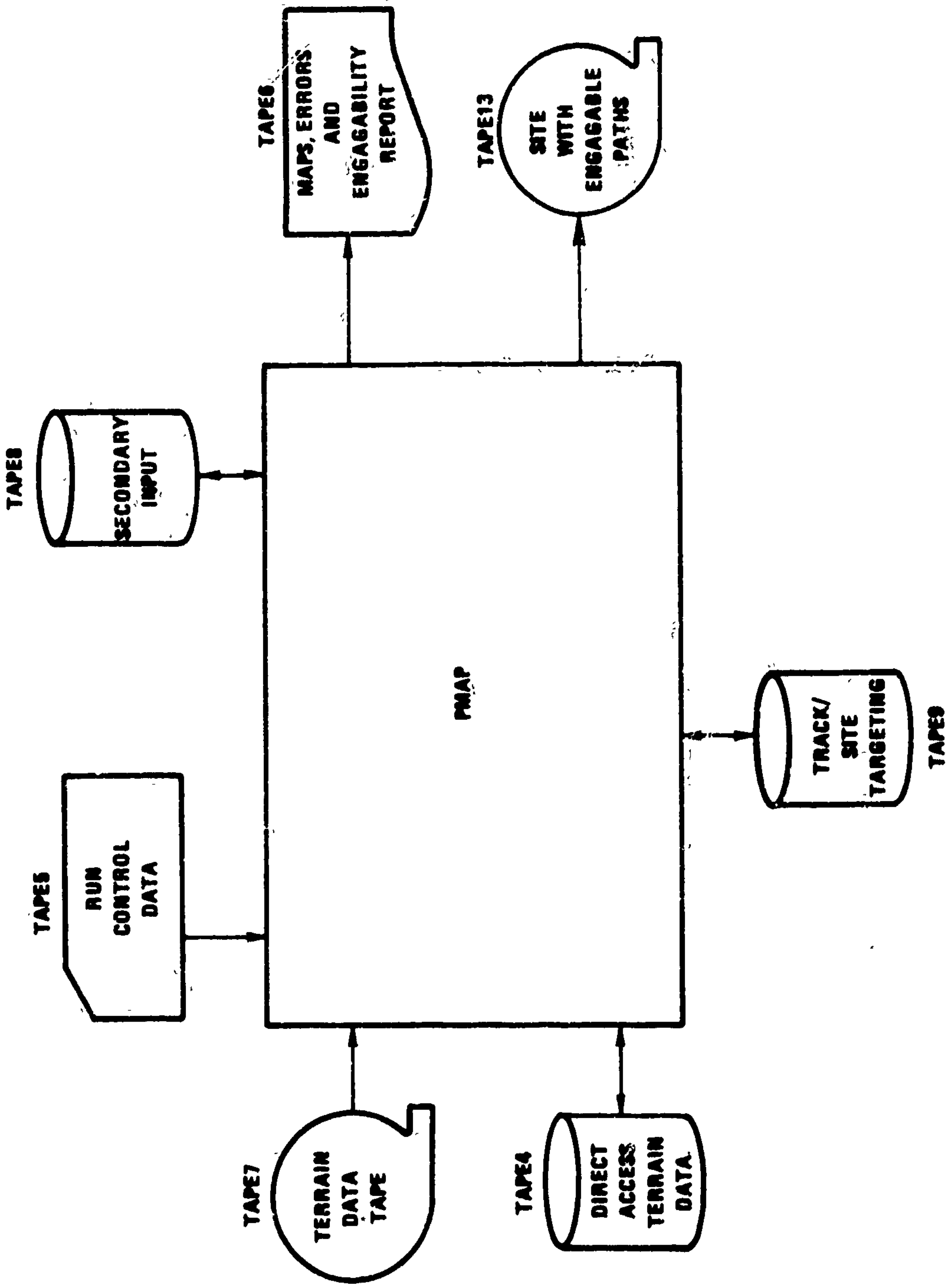

Figure P.1-1. PMAP Data Flow

P.1.1.2 Path Data Checking

As the path data are read, PMAP checks each path leg to determine if its length is unusually long. For each input point, except for first and last, the turning angle is tested to determine if this angle is excessive. If either of these conditions are detected, an appropriate message is printed in the path description table.

P.1.1.3 Targeted Path Identification

PMAP identifies paths which the analyst has targeted against specific sites. As the path points are input, a check is performed and the identifier of the site for which the path is targeted is entered in the path table.

P.1.1.4 Path Engageability Identification

For each site, PMAP determines the paths which pass within the site range of interest. These paths are considered engageable by these sites.

P.1.1.5 Map Plotting

A PMAP plot consists of printing the site identifiers at the site locations or the path point sequence numbers at the point location on a UTM grid system. One plot is printed for all the site locations and one plot for each of the input paths.

P.1.2 Run Resources Required

PMAP requires the following resources for running:

- CDC 6600 computer with at least a 27,776 word (decimal) region available.
- One tape drive for the terrain data input file.
- Random access mass storage device for storage of the working data file, secondary record inputs and path/site targeting records.

- A card reader suitable for data input.
- A printer capable of printing either 6 or 8 lines per inch, but not necessarily both.
- A terrain data tape containing the digitized terrain data for the regions of interest.
- Input cards describing the air defense systems, site locations and vehicle paths.

P.2 DATA REQUIREMENTS

PMAP requires the digitized terrain data for the region under consideration. Regions for which data are currently available are: 32UF for West Germany (with foliage), 32U for West Germany (without foliage), 00A for Okinawa, 51S for Korea (West zone), 52S for Korea (East zone) and 19T for Boston. (The region identifiers are related to the UTM grid zone where the included data lie.) The tape format is detailed in Volume IIA.

P.2.1 Card Type Functional Definitions

In order to perform the preliminary site and track check, PMAP expects the UTM grid zone designator specifying the terrain to be used, system data, site data, and path data. The following is a narrative description of each card function.

P.2.1.1 Type 1 Card (SWITCH)

The Type 1 (SWITCH) card specifies the terrain data base to be used for data checking and several flags identifying the optional printouts desired. Parameters set on a Type 1 card are:

- UTM grid zone name.
- The coordinate system origin.
- The number of lines to be printed per inch.
- The plot scale.
- The maximum path leg length.

- Flags indicating whether or not to check terrain availability, whether or not to punch site cards for sites with engageable paths, whether or not to suppress plotting, whether or not to check site engageability, and whether or not to print site sectors.

Only one Type 1 card is allowed for each PMAP run and parameters set are valid for that complete run.

P.2.1.2 Type 2 Cards (SYSTEM)

A Type 2 (SYST) card specifies the range of interest (engagement range) for each air defense system type. There must be one Type 2 card for each system name referred to on the Type 3 (SITE) cards.

P.2.1.3 Type 3 Cards (SITE)

The Type 3 (SITE) cards specify site system type, site location, altitude, and azimuth sectors. One Type 3 card must be input for each site to be tested. The maximum number of sites which may be input is 255.

P.2.1.4 Type 4 Cards (TRACK)

The Type 4 (TRACK) card specifies the number of path points expected for this path. One Type 4 card must precede each set of path points. A maximum of 255 Type 5 cards are allowed.

P.2.1.5 Type 5 Cards (PØINT)

The Type 5 (PØINT) cards specify data for a point on the input path. A Type 5 card specifies the following:

- Point location, altitude, and sequence number.
- Path identifier.
- Path point identifier to be used in conjunction with the site identifier for path targeting.

The maximum number of Type 5 cards for any one PMAP run is 972.

P.2.2 Input Data Deck Sequencing

Figure P.2-1 illustrates a typical data deck sequence for a PMAP run. Only one Type 1 card is allowed. Up to 15 Type 2 cards may be specified for any one PMAP run. PMAP allows a maximum of 255 Type 3 cards. One and only one Type 4 card must precede each set of Type 5 cards. The total number of Type 5 cards must not exceed 972.

P.2.3 Input Variables Definitions, Usages, Interactions, and Formats

This paragraph contains a detailed description of each PMAP input card in tabular form. The information presented includes the card type numbers, the conditions under which the card is (or is not) read, the variable names into which the data are read, the card columns into which the data must be punched, the permissible range of its values, the FORTRAN format of each variable, and the variable descriptions. The column for interactions contains the documentation volume and page number where the interactions are described. Finally, notes on card and variable usage are included.

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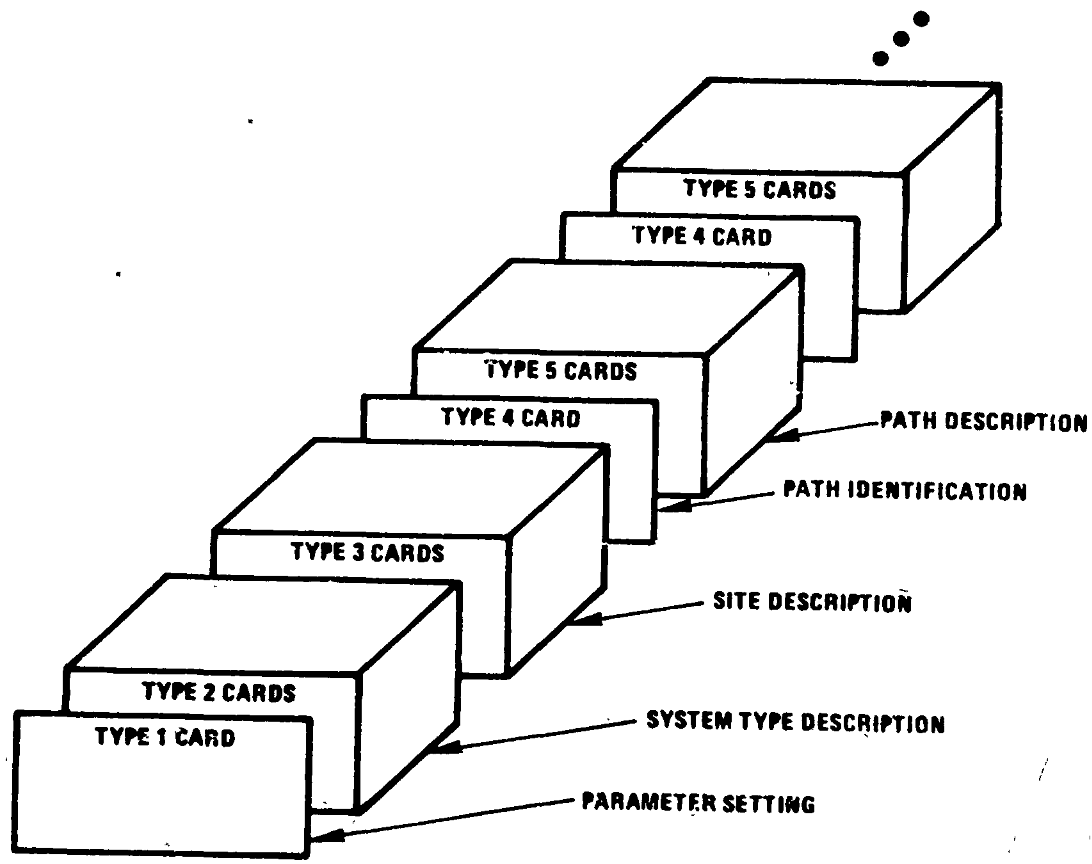

Figure P.2-1. PMAP Data Deck Sequencing

TACOS PROGRAM: PMAP	CARD TYPE: 1	FUNCTIONAL USE: Provide program control

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: One and only one Card Type 1 (SWITCH) must be read for each PMAP run.

VARIABLE NAME	CARD COLUMNS	VARIABLE RANGE	CARD FORMAT	INTERACTIONS	VARIABLE DESCRIPTION
IØP	1-4	N.A.	A4		Card name must be 'SWIT' ('CH' may occur in columns 5 and 6.)
KGZ	7-10	N.A.	A4	P.4.MAIN-I VOL IID	UTM grid zone name: '32UF' for W. Germany (With foliage), '32U' for W. Germany (Without foliage), '00A' for Okinawa, '51S' for Korea (West zone), '19T' for Boston. (4 characters)
KØR	14-15	N.A.	A2	P.4.MAIN-I VOL IID	UTM grid square designator of the coordinate system origin.
NLPI	16-20	6 or 8	I5	P.4.MAIN-I VOL IID	Number of lines per inch printer setting.
SCALE	21-30	> 0	F10.0	P.4.MAIN-I VOL IID	Scale in ground meters per printed inch.
RNMAX	31-40	> 0	F10.0	P.4.MAIN-I VOL IID	Maximum length of track segment. (meters).

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TACOS PROGRAM: PMAP	CARD TYPE:1 (Cont'd.)	FUNCTIONAL USE: Provide program control

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: One and only one Card Type 1 (SWITCH) must be read for each PMAP run.

VARIABLE NAME	CARD COLUMNS	VARIABLE RANGE	CARD FORMAT	INTERACTIONS	VARIABLE DESCRIPTION
ANGØ	41-45	$0-180^{\circ}$	F5.4	P.4.MAIN-1	Maximum turning angle of the path. Degrees
ZTER	50	T or F	L1	P.4.MAIN-1 VOL IID	'T' causes terrain availability and site altitude checking. 'F' or blank indicates terrain will not be considered.
ZPNCH	51	T or F	L1	P.4.MAIN-1 VOL IID	'T' causes site cards for the sites which engage at least one path to be punched on file 7. 'F' or blank indicates no site punch will occur.
ZNØPLT	52	T or F	L1	P.4.MAIN-1 VOL IID	'T' causes all plotting to be suppressed. 'F' or blank allows plotting of site and track point maps.
ZNØENG	53	T or F	L1	P.4.MAIN-1 VOL IID	'T' causes path engageability not to be tested. 'F' or blank causes each site's ability to engage the paths to be tested.
ZNØSEC	54	T or F	L1	P.4.MAIN-1 VOL IID	'T' causes site sectors to be ignored. 'F' or blank causes site sectors to be printed in the site description table.

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TACOS PROGRAM: PMAP	CARD TYPE: 2	FUNCTIONAL USE: Specify system data

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: There must be one Type 2 (SYSTEM) card for each system referred to from a Type 3 (SITE) card. Limit 15.

VARIABLE NAME	CARD COLUMNS	VARIABLE RANGE	CARD FORMAT	INTERACTIONS	VARIABLE DESCRIPTION
IØP	1-4	N.A.	A4		Card name must be 'SYST' ('EM' in columns 5 and 6 allowable.)
IDSYS	7-10	N.A.	A4	P.4.MAIN-J VOL IID	System identifier. Links the system range to any site specifying this name as IDFU on the SITE card.
RANMAX	11-20	RANMAX > 0.	F10.0	P.4.MAIN-J VOL IID	Maximum range from each site of this system type to which a target can be detected. Meters.

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TACOS PROGRAM: PMAP	OPERATOR TYPE: 3	FUNCTIONAL USE: Specify sites

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: Use one Type 3 (SITE) card for every site to be plotted. If only track plots are desired, there need be no Type 3 cards. Limit 252.

KEYWORD NAME	NO. OF PARAMETERS	PARAMETER POSITION	PARAMETER RANGE	INTERACTIONS	PARAMETER DESCRIPTION
IØP	1-4	N.A.	A4		Card name must be 'SITE'.
IFTYP	11-14	N.A.	A4	P.4.MAIN-J VOL IID	System identifier. Link to system data on card Type 2.
IDF	15-18	N.A.	A4	P.4.MAIN-J VOL IID	Site identifier. This is the name which must appear on the Type 5 (PØINT) card for track targeting to be tested.
LTRS } NBRS }	21-22 23-30	N.A. 0-99999999	A2 I8	P.4.MAIN-J VOL IID	UTM coordinates of the site location. (2 letters - 1 digit integer)
ZF	31-38	ZF>0.	F8.0	P.4.MAIN-J VOL IID	Altitude of the site above Mean Sea Level (MSL). Meters.
AZ1	40-45	0°-360°	F6.1	P.4.MAIN-J VOL IID	Right azimuth sector edge. Degrees $0^\circ \rightarrow$ Grid North; $90^\circ \rightarrow$ East
AZ2	47-52	0°-360°	F6.1	P.4.MAIN-J VOL IID	Left azimuth sector edge. Degrees $0^\circ \rightarrow$ Grid North; $90^\circ \rightarrow$ East

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TACOS PROGRAM: PMAP	CARD TYPE: 4	FUNCTIONAL USE: Specify penetrator paths

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: Use one Type 4 (TRACK) card for every path to be plotted. If only site plots are desired, there need be no Type 4 cards. Limit 252.

VARIABLE NAME	CARD COLUMNS	VARIABLE RANGE	CARD FORMAT	INTERACTIONS	VARIABLE DESCRIPTION
IØP	1-4	N.A.	A4		Card type must be 'TRAC'. ('K' in column 5 allowable.)
IDTHV	11-14	N.A.	A4	P.4.MAIN-K VOL IID	Penetrator type identifier.
IDTRK	16-20	N.A.	I5	P.4.MAIN-K VOL IID	Penetrator path identifier.
MNP	21-25	2-372	I5	P.4.MAIN-K VOL IID	Number of path points to be specified for this path.

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TACOS PROGRAM: PMAP | **CARD TYPE:** 5 | **FUNCTIONAL USE:** Specify vehicle path points

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: At least two Type 5 (PØINT) cards must follow each Type 4 (TRACK) card. There is a maximum of 972 points for each PMAP run.

VARIABLE NAME	CARD COLUMNS	VARIABLE RANGE	CARD FORMAT	INTERACTIONS	VARIABLE DESCRIPTION
IØP	1-4	N.A.	A4		Card name must be 'PØIN'. ('T' in column 5 allowable.)
LTRS NBRS	11-12 13-20	N.A. 0-99999999	A2 I8	P.4.MAIN-M VOL IID	UTM coordinates of the path point. (2 letters - 8 digits integer)
ZTK	21-30	ZTK>0.	F10.2	P.4.MAIN-M VOL IID	Altitude of the path point above Mean Sea Level. Meters.
VEL	31-40	VEL>0.	F10.2	P.4.MAIN-M VOL IID	The velocity of the vehicle approaching the point. Meters per second.
IDCP	42-45	N.A.	A4	P.4.MAIN-M VOL IID	Checkpoint code. Input in order to get a status on the vehicle at that point.
IDTK	46-50	N.A.	I5	P.4.MAIN-M VOL IID	Identifier of path of which this point is a member. (Match with IDTRK on TRACK card.)
IP	51-55	1-972	I5	P.4.MAIN-M VOL IID	Point sequence number. Printed in path description table.
IDTP	62-65	N.A.	A4	P.4.MAIN-M VOL IID	Identifier of the track point. Must match IDF on Type 3 (SITE) cards for targeted track test.

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P.2.4 Relationship of Input Variables to Influenced Submodels

PMAP utilizes the following five submodels: Site Data Checking, Path Data Checking, Targeted Path Identification, Path Engageability Identification, and Map Plotting.

P.2.4.1 NAME: Site Data Checking

P.2.4.1.1 Input Variables Affecting This Submodel:

CARD TYPE	VARIABLE NAME	DESCRIPTION
1	ZTER	FALSE - implies terrain availability or site altitude checks will not be performed.

P.2.4.1.2 Other Submodels Affecting This Submodel: None

P.2.4.1.3 Algorithm Description:

For each input site, the availability of terrain data at that site location is tested. If terrain data are available at the site location, this terrain elevation is compared with the input site altitude. A check is then performed to determine if a duplicate site card, duplicate site identifier, or duplicate site location has been specified. If any one of the above checks finds an "error," a message is printed in the site description table.

P.2.4.1.4 Alternate Algorithms: None

P.2.4.1.5 Examples of Inputs and Their Effects:

If ZTER is specified FALSE or left blank, the site location may be off available terrain or below terrain elevation without the analyst being aware.

P.2.4.2 NAME: Path Data Checking

P.2.4.2.1 Input Variables Affecting This Submodel:

CARD TYPE	VARIABLE NAME	DESCRIPTION
1	RNMAX	All path legs longer than RNMAX are marked.
1	ANGØ	All path points at which this maximum turning angle is exceeded are marked.

P.2.4.2.2 Other Submodels Affecting This Submodel: None

P.2.4.2.3 Algorithm Description:

As the path points are read, the path leg lengths are calculated and a message output in the path description table if this length exceeds RNMAX. At each input path point (except the first and last), the turning angle is calculated and if this angle exceeds ANGØ, a message is printed in the path description table.

P.2.4.2.4 Alternate Algorithms: None

P.2.4.2.5 Examples of Inputs and Their Effects:

ANGØ and RNMAX may be used to detect paths points which have been erroneously specified.

P.2.4.3 NAME: Targeted Path Identification

P.2.4.3.1 Input Variables Affecting This Submodel:

CARD TYPE	VARIABLE NAME	DESCRIPTION
3	IDF	These two identifiers must match in order for path targeting to be tested.
5	IDTP	

3	LTRS NBRS	The site and point location must be within 25 meters ground range for targeting to be detected.
5	LTRS NBRS	

P.2.4.3.2 Other Submodels Affecting This Submodel: None

P.2.4.3.3 Algorithm Description:

For each designated path point and site combination, the ground range from the site location to the path point is determined. If this distance is less than 25 meters, this path point is targeted for this site and the combination is added to the targeting table.

P.2.4.3.4 Alternate Algorithms: None

P.2.4.3.5 Examples of Inputs and Their Effects:

If a site and path point identifier are equal, and the site location and point location are within 25 meters ground range, then the site and path will be specified in the targeted path table.

P.2.4.4 NAME: Path Engageability Identification

P.2.4.4.1 Input Variables Affecting This Submodel:

CARD TYPE	VARIABLE NAME	DESCRIPTION
1	ZNØENG	TRUE -implies engageability is not to be tested.

CARD TYPE	VARIABLE NAME	DESCRIPTION
2	RANMAX	The path must be closer than RANMAX before the path is considered engageable.
3	LTRS NBRS	Site location determines the number of selected paths intersecting this engagement volume.
5	LTRS NBRS	Path points determines wheather a path intersects a selected engagement volume.

P.2.4.4.2 Other Submodels Affecting This Submodel: None

P.2.4.4.3 Algorithm Description:

For each site/path combination the vehicle path is checked, path leg by path leg, to determine if this path intersects the site's engagement volume. After all paths have been tested for intersection with this engagement volume, a table is printed to indicate which paths intersect this engagement volume. This continues until all site/path combinations have been tested and a summary of the unengageable paths and inactive sites are printed.

P.2.4.4.4 Alternate Algorithms: None

P.2.4.4.5 Examples of Inputs and Their Effects

If engageability is being tested and the ground range between any path and the site location is less than the site range of interest (engagement range), this track is considered engageable.

P.2.4.5 NAME: Map Plotting

P.2.4.5.1 Input Variables Affecting This Submodel:

CARD TYPE	VARIABLE NAME	DESCRIPTION
1	SCALE	Sets the plot scale.
1	ZNØPLT	TRUE -implies no site or path plotting is desired.

P 2.4.5.2 Other Submodels Affecting This Submodel: None

P.2.4.5.3 Algorithm Description

Upon initiation of point plotting, the points are sorted so that the points to be plotted lie in order of descending northing. The map width which will fit across one page is determined and a plot of the western-most strip is printed. If more points are still available for plotting, the next map strip east is printed. This process continues until all the map strips have been printed.

P.2.4.5.4 Alternate Algorithms: None

P.2.4.5.5 Examples of Inputs and Their Effects:

The larger the value of SCALE, the fewer strips will be required for plotting.

P.2.5 Input Conventions

P.2.5.1 General

The following conventions are used within the TACOS II input descriptions.

CHARACTERS	CONVENTION
Letters - o	Ø
i	I
Numbers - 0	0
1	1
Blank - (space)	ƀ

LOGIC

Implication (ØRDER)	→

For example: 'SITE' → Site

Explicit characters to be input in prescribed data fields appear within single quotation marks; e.g., 'ØTRR'.

P.2.5.2 FORTRAN Codes

The general FORTRAN input format codes are:

aIw	Integer data fields.
aFw.d	Real (floating point) data field.
aEw.d	Real (floating point) data field.
aØw	Octal data field.
aLw	Logical data field.
aAw	Alphanumeric data field.
wX	Indicates that a field is to be skipped.
a(...)	Indicates a group format specification.

where: a is optional and is an unsigned integer constant used to denote the number of times the format code is to be used. If a is omitted, the code is used only once.

w is an unsigned integer constant specifying the number of characters of data in the field.

d is an unsigned integer constant specifying the number of decimal places to the right of the decimal point, i.e., the fractional portion.

(...) within the parentheses are format codes separated by commas. The a preceding this form is the group repeat count.

P.2.5.2.1 Integer Data Field Notes

Do not use special or alphabetic characters; e.g., letters A to Z, commas (,), slashes (/), @'s, decimal points, etc.

A blank field is considered to be zero; i.e., same as entering '0' in that field.

All data should be right justified within the field. If the data are not right justified within the field, the remaining fields to the right of the actual data will be filled with significant zeroes.

P.2.5.2.2 Real (Floating Point) Data Field Notes

A decimal point need not be provided in the data; however, the program will assume the decimal point is located as indicated in the format code; e.g., Format code F4.2 and input data right justified 199 will be interpreted as 1.99.

Do not use special or alphabetic characters; i.e., letters A to Z, $, @, etc. A decimal point (.) and a minus sign (-) are valid.

If a decimal point is to be input in a field, its position overrides the position indicated by the d portion of the format code and the positions reserved by w must include a place for the decimal point.

Leading, embedded, and trailing blanks in the field are interpreted as zeroes.

For very large numbers, the number can be input through the use of decimal exponents, i.e., powers of 10. This is done by following the desired significant figure (with the decimal point anywhere in the figures) with the letter "E" and the appropriate power of 10. For example:

1300000000000000000000

may be written as

1.3E+21 or .13E+22 or 1.3E21.

.0000000000000000009

may be written as

.9E-19 or 9.E-20

The exponent field is treated as an integer and must be right justified in the field; otherwise, trailing blanks are interpreted as zeroes.

P.2.5.2.3 Octal Field Data Notes

Octal digits have the following correspondence to decimal numbers:

0	1	2	3	4	5	6	7	10	11	12	octal
0	1	2	3	4	5	6	7	8	9	10	decimal

They are used to set random number bases or to serve through their internal binary representation as a series of on/off switches.

P.2.5.2.4 Logical Data Field Notes

They are used for input of logical decisions; TRUE or FALSE.

The first T or F encountered (reading left to right) in the logical data field causes a value of TRUE or FALSE, respectively.

All blanks in the field are interpreted as FALSE.

P.2.5.2.5 Alphanumeric Data Field Notes

Any alphabetic or special character may be used in this type of field.

Numbers may be used within this field and they are considered as characters.

A blank (b̸) is a character and has the same validity as the other characters.

All alphanumeric identifiers of entities and entity characteristic categories are arbitrary.

P.3 RUN DECK SETUP

The MICOM version of TACOS II was designed to be run on a CDC 6600 with an operating system of Scope 3.4. This section describes the control cards to be used for a typical run. Also, examples of various combinations of input control cards are given.

P.3.1 Typical Control Card Setup

The data requirements and formats for PMAP have been thoroughly discussed in previous sections. It remains only to show an example of a typical run which was made on the MICOM computer. This is shown in Figure P.3-1. All control and request cards are shown, as well the relative locations of FORTRAN and data decks. In order to show the reader what is required for compilation, the example setup is for both compile and run.

P.3.2 Input Data Deck Example

Figure P.3-2 is an example PMAP input data deck. As illustrated, the Type 1 card specifies a grid zone of 32UF and specifies that terrain availability and path engagability are to be tested. The following three cards specify system types of SYAA, SYGB, and SYMB with respective ranges of interest of 78K, 3.5k, and 35k, respectively. Three sites, one each for the above system types, are considered. Three paths are specified, none of which are to be tested for targeting.

```
ACCT(PN=ARNDT,PBC=360405,900,CC=3600,JN=
1692,OP=A2)
LIMIT,256.
REQUEST,OLDPL,HY.                    S04695
UPDATE(F,P=OLDPL)
RETURN,OLDPL.
REQUEST,TAPE7,HY.                   S04574
REWIND,TAPE7.
FTN(I=COMPILE)

&
            •
            •
            •
      - FORTRAN DECK -
            •
            •
            •
&
&           •
            •
            •
        - DATA DECK -
            •
            •
            •
&
&
```

Figure P.3-1. Sample PMAP Deck Setup

```
SWIT   32UF    KT     9    1000 0.      30000.  45.          T
SYST   SYAA      78000.
SYST   SYGH      3500.
SYST   SYMP      35000.
SITE         SYAAA023  LA95002100       0.      4 .   -167.
SITE         SYAA031   NV45105410       0.    338.    -98.
SITE         SYGHG210  NA985059 0       0.       0.    360.
SITE         SYMPM001  LA79002950       0.        .    360.
TRACK        TYAA 1009      12
POINT        PA20001000       9150.       250.         1009     1
POINT        PA01607580       9150.       250.         1009     2
POINT        NA80003600       9150.       250.         1009     3
POINT        NV28606740       915 .       250.         1009     4
POINT        NV20066300       9150.       250.         1009     5
POINT        NV18006280       9150.       300.         1009     6
POINT        NV16806350       915 .       300.         1009     7
POINT        NV16806570       9150.       300.         1009     8
POINT        NV27007000       9150.       300.         1009     9
POINT        NA75004000       915 .       300.         1009    10
POINT        NA98007600       9150.       300.         1009    11
POINT        PA2 001000       9150.       300.         1009    12
```

P.3-2. Example PMAP Input Data Deck

P.4 OUTPUT DATA DEFINITIONS

P.4.1 Output Report Sequencing

P.4.1.1 Flowchart

The PMAP output report sequencing flowchart is shown in Figure P.4-1. In general, the site and path tables are automatically provided PMAP reports, but the PMAP plots may be suppressed.

P.4.1.2 Systems Data Table

As the system types are read, a table containing the system identifiers and range of interest for each site is printed. See Figure P.4-2.

P.4.1.3 Site Data Table

As the sites are input, the site data corresponding to that site are printed in the site description table. Each site description contains the system type, site name, site location, input site altitude, site altitude above terrain, left and right edge of sector, site easting and northing, and messages corresponding to any error detected. See Figure P.4-3.

P.4.1.4 Site Plot

The site identifier of each site is plotted at the site location on a UTM grid. See Figure P.4-4.

P.4.1.5 Path Data Table

The path data table consists of a heading indicating the path identifier and number of expected points and a one line description of each path point. The point description consists of the path identifier, point location in both UTM and relative coordinates, path point altitude, time elapsed to reach this point, vehicle velocity approaching this point, check point code, point sequence number, targeting identification, leg length preceding this point, and messages corresponding to errors detected. See Figure P.4.-5.

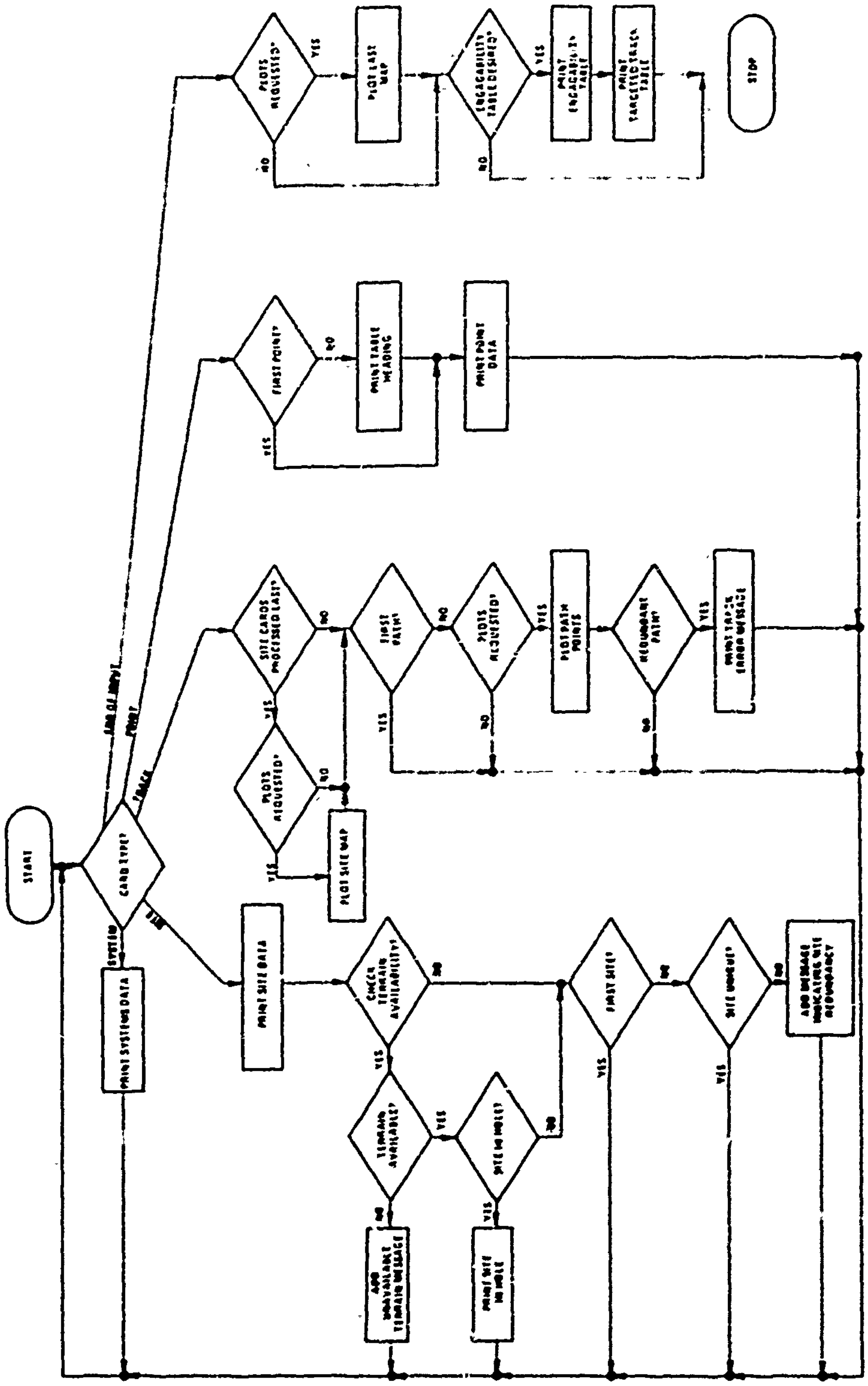

Figure P.4-1. PMAP Output Report Sequencing Flowchart

S Y S T E M   D A T A

NO.	SYSTEM IDENTIFIER	RANGE OF INTEREST
1	SYAA	7,000.
2	SYBA	7,000.
3	SYHB	3,000.
4	SYG[illegible]	3500.
5	SYMC	3,000.
6	SYKM	35000.
7	SYM3	3,000.
8	SYMD	50,000.

SYSTEM IDENTIFIER
AND SEQUENCE NUMBER

Figure P.4-2. PMAP Systems Data Table

#	SITE	COORDINATE	ELEVATION	HEIGHT	SECTOR	XSITE	YSITE	ERROR MESSAGES
1	SYAAA023	LA95CC2100	0.	-4[illegible]0.	-7.-167.	19 000	321000.	THIS SITE IS IN A HOLE!
2	SYAAA031	MV45105410	0.	-122.	338.- 95.	24 100.	254100.	THIS SITE IS IN A HOLE!
3	SYAAA032	LV740C4993	0.	-232.	3.2.-112.	17-300.	249900.	THIS SITE IS IN A HOLE!
4	SYBAB003	NA 2.03200	0.	-3.0.	3 5.-116.	302500.	382000.	THIS SITE IS IN A HOLE!
5	SYBAB011	NA23003750	0.	-450.	3.-123.	323000.	337500.	THIS SITE IS IN A HOLE!
6	SYBAB015	NV9407550	0.	-520.	10.-130.	394000.	275500.	THIS SITE IS IN A HOLE!
7	SYHB4833	NA91505130	-0.	-3 0.	0.-360.	391500.	301500.	THIS SITE IS IN A HOLE!
8	SYHB4833	NA31C03500	-0.	-460.	0.-360.	391500.	305000.	THIS SITE IS IN A HOLE!
9	SYHBH849	NA86004150	-0.	-210.	0.-360.	383000.	341500.	THIS SITE IS IN A HOLE!
10	SYGB3212	NA98C03950	0.	-320.	0.-360.	395500.	309500.	THIS SITE IS IN A HOLE!
11	SYGB3233	NA93C06750	0.	-360.	0.-360.	393500.	367500.	THIS SITE IS IN A HOLE!
12	SYGBG576	MV7410707C	0.	-110.	0.-360.	274000.	270700.	THIS SITE IS IN A HOLE!
13	SYKBK008	LA57003400	423.	3.	0.-360.	161000.	334000.	
14	SYKBK009	LA72003400	423.	3.	0.-360.	172000.	334000.	
15	SYMCN001	LA74502950	473.	3.	0.-360.	174000.	129500.	
16	SYMBM002	LA76002800	403.	3.	0.-360.	176000.	328000.	
17	SYMBM003	LA79C03300	453.	3.	0.-360.	179500.	333000.	
18	SYMO0025	NA32203390	0.	-310.	28.-148.	232200.	303900.	THIS SITE IS IN A HOLE!
19	SYMO0026	MV20208700	0.	-326.	330-150.	222200.	287000.	THIS SITE IS IN A HOLE!
20	SYMO0027	LV75109310	0.	-212.	17.-137.	17 100.	290100.	THIS SITE IS IN A HOLE!

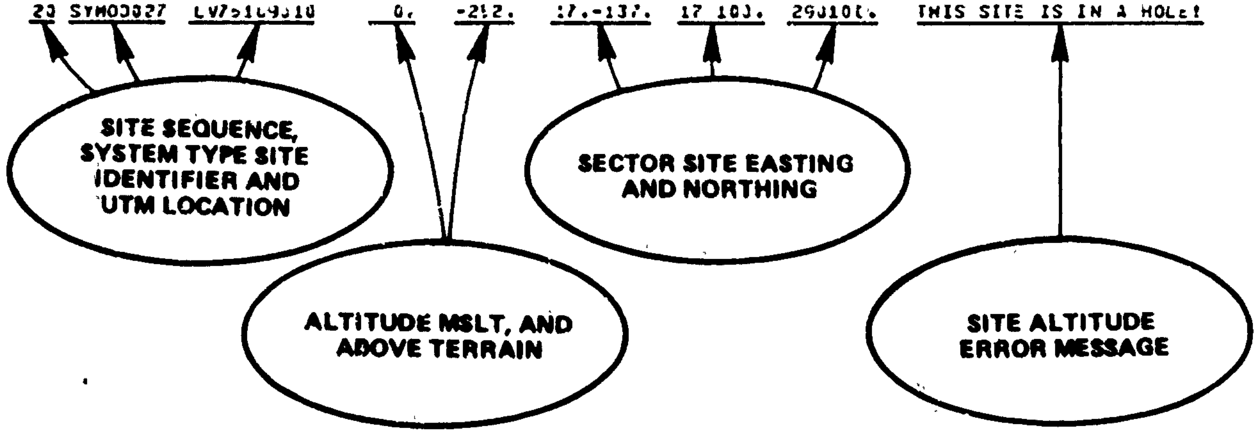

Figure P.4-3. PMAP Site Data Table

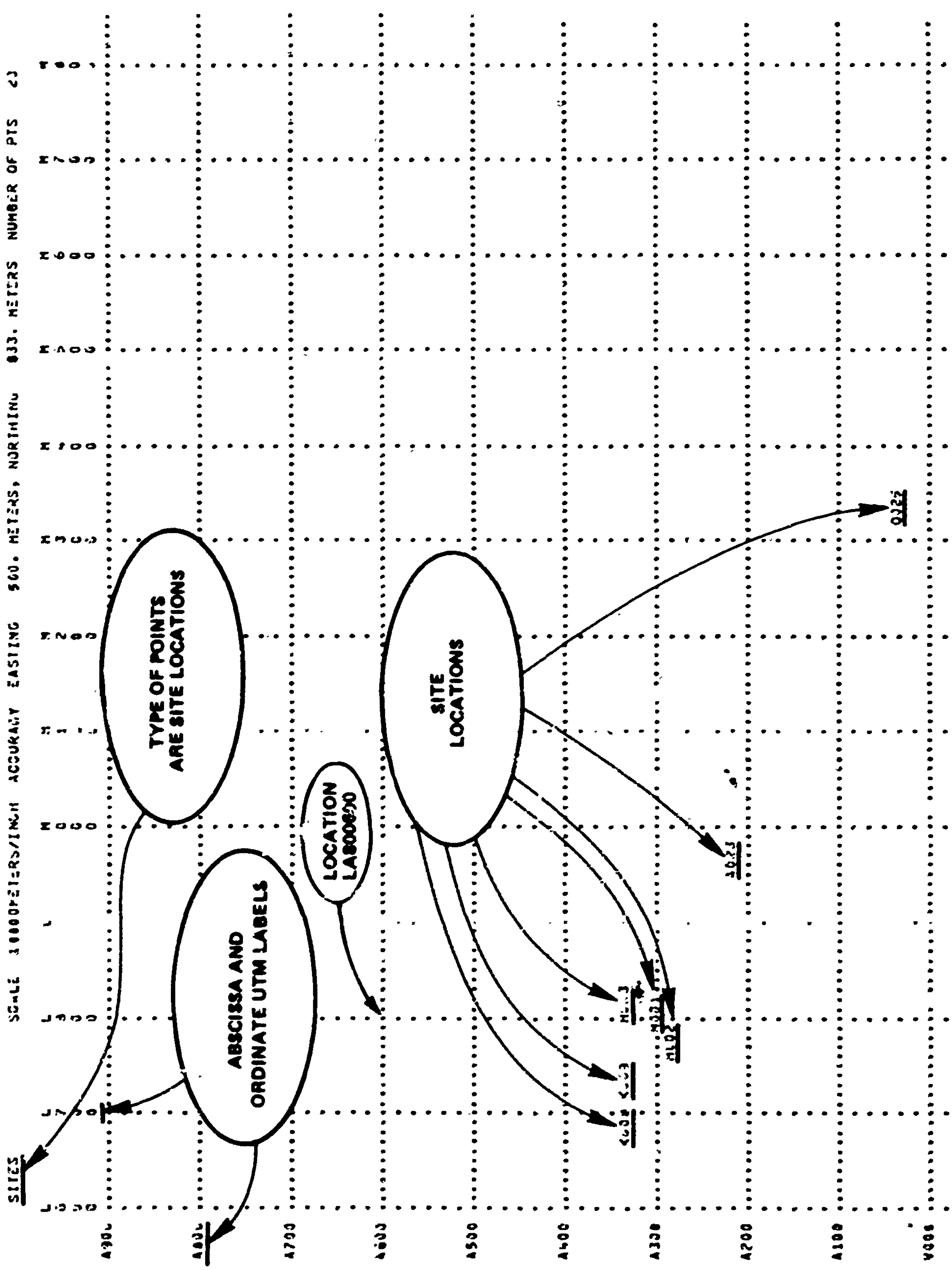

Figure P.4-4. PMAP Site Plot

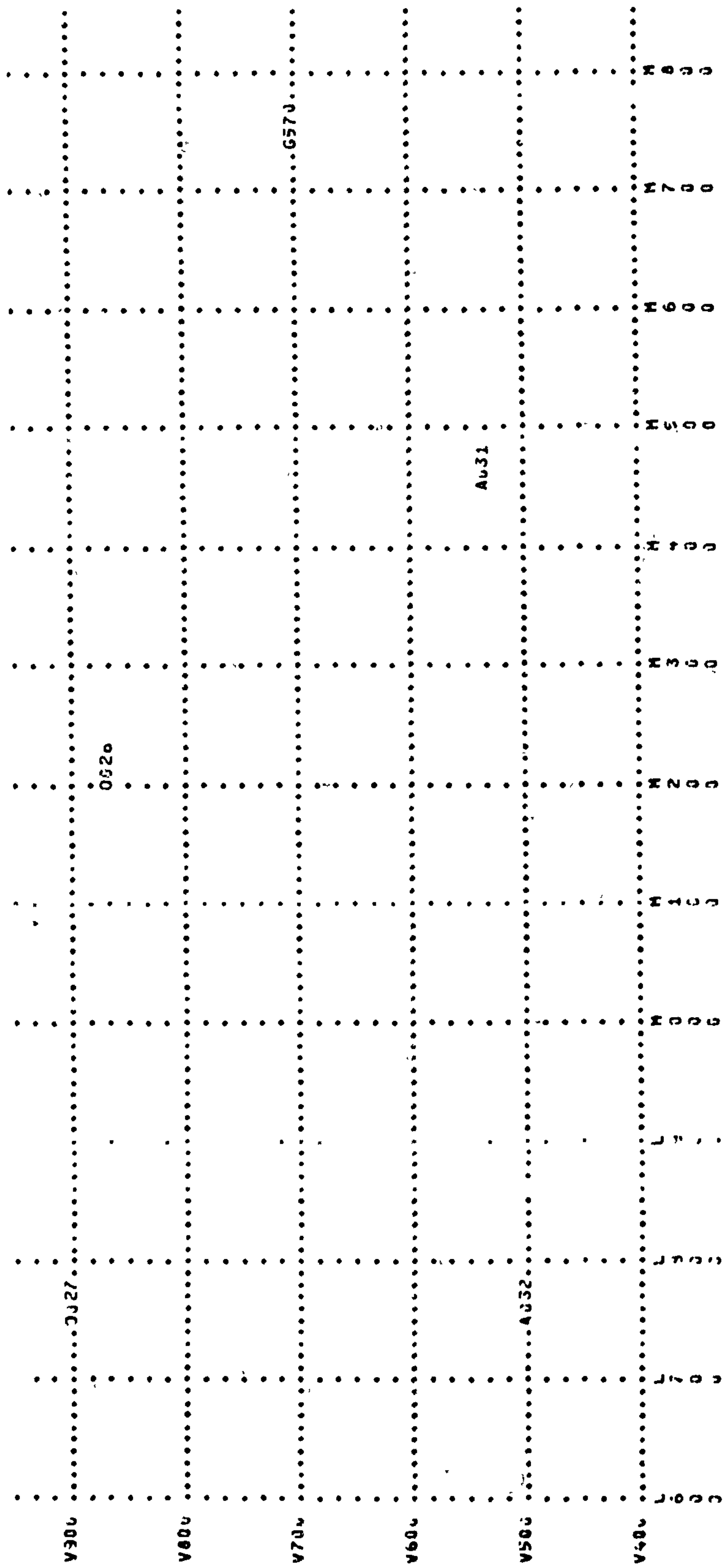

Figure P.4-4. PMAP Site Plot (Continued)

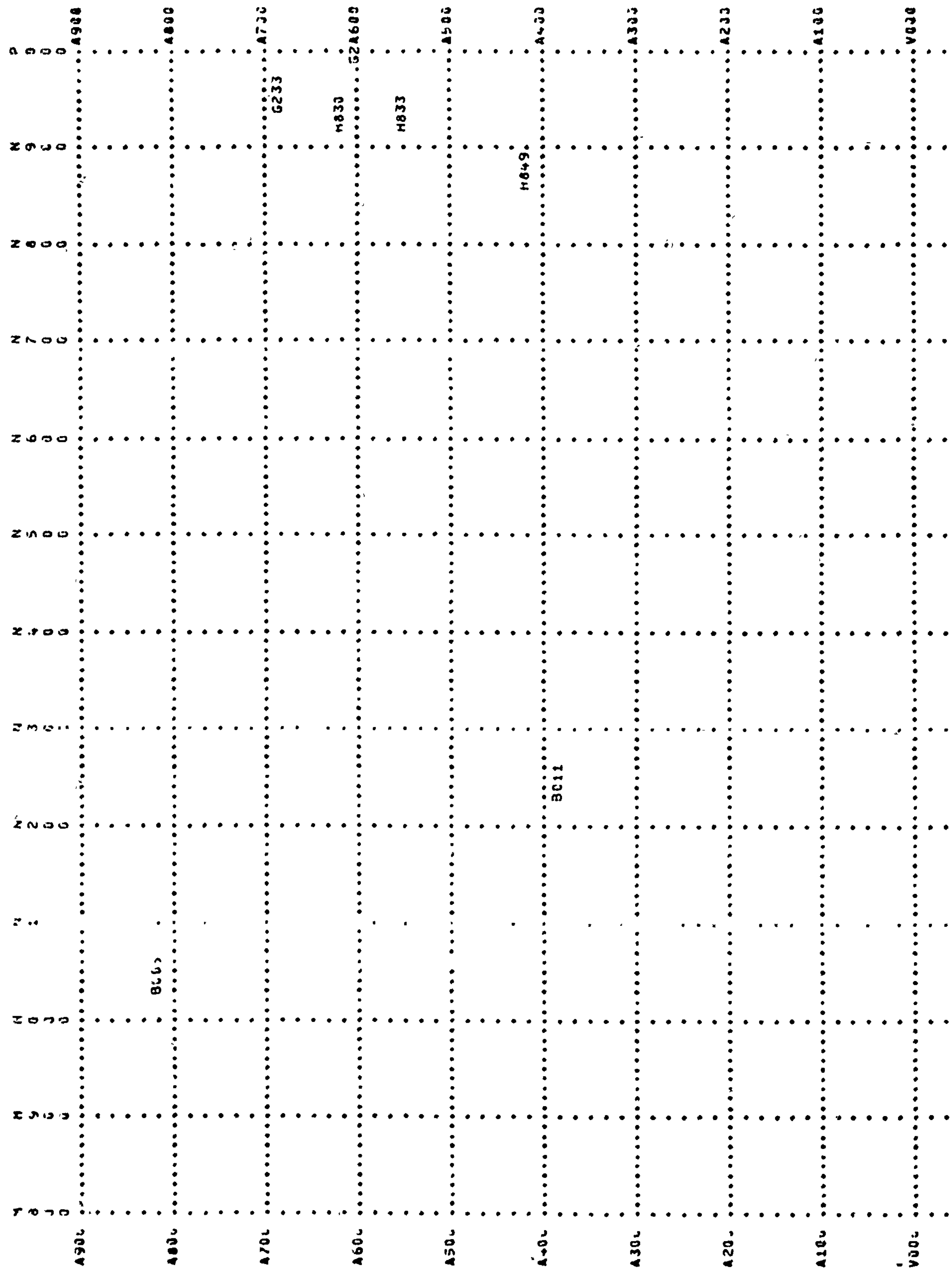

Figure P.4-4. PMAP Site Plot (Continued)

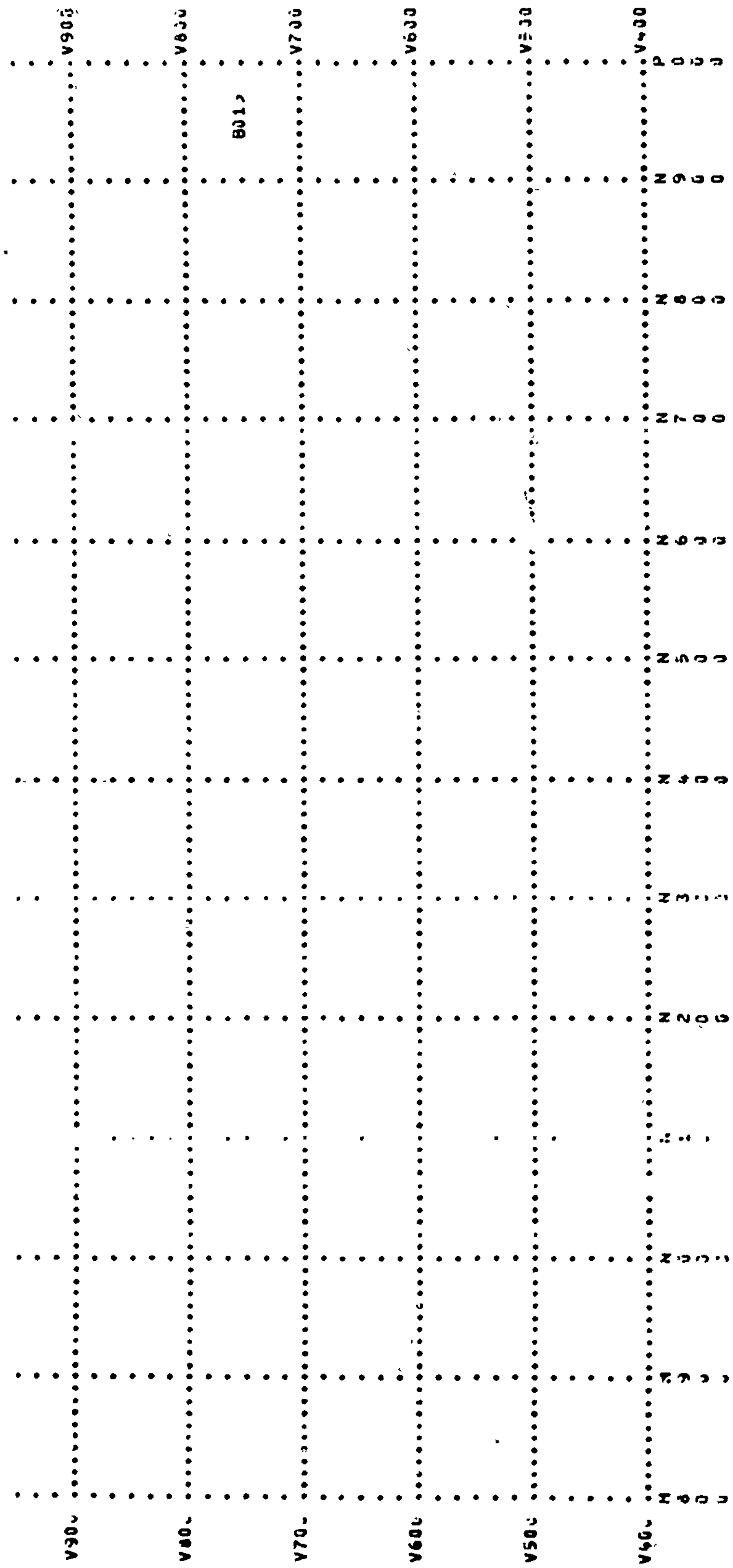

Figure P.4-4. PMAP Site Plot (Concluded)

TVAA 1009 12

IDTRK	COORDINATE	XTRACK	YTRACK	ZTRACK	TTRACK	VELOCITY	CKPT	TKID	PT	SITE	TRG	SEG LENGTH	
1009	PB21001000	420000.	41[illegible]	91[illegible]	0.00	250.	5555	1009	1		F	0.0	
1009	PA 1507580	401500.	3[illegible]	91[illegible]	155.34	250.	5555	1009	2		F	35835.6	
1009	NA8[illegible]003000	380000.	336[illegible]	91[illegible]	335.48	250.	5555	1009	3		F	45283.6	
1009	NV28666740	328000.	257[illegible]	91[illegible]	679.35	250.	5555	1009	4		F	85720.3	UNUSUALLY LONG
1009	NV20005300	320000.	253[illegible]	91[illegible]	718.00	250.	5555	1009	5		F	9660.2	
1009	NV18000280	318000.	2526[illegible]	91[illegible]	724.70	300.	5555	1009	6		F	2010.0	
1009	NV16006350	316000	253[illegible]	91[illegible]	729.33	300.	5555	1009	7		F	1389.2	
1009	NV16500570	316500.	2357[illegible]	91[illegible]	736.65	300.	5555	1009	8		F	2200.0	
1009	NV27007000	327000	2[illegible]	91[illegible]	773.56	300.	5555	1009	9		F	11069.3	
1009	NA75004000	375000.	3[illegible]	91[illegible]	1256.48	300.	5555	1009	10		F	84876.4	UNUSUALLY LONG
1009	NA95007000	395000.	376[illegible]	91[illegible]	1196.88	300.	5555	1009	11		F	42720.0	
1009	PB20001000	420000.	41[illegible]	91[illegible]	1333.87	300.	5555	1009	12		F	40496.9	

TRACK IDENTIFIER

POINT LOCATION IN UTM AND RELATIVE COORDINATES, POINT ALTITUDE, TIME TO REACH POINT, VELOCITY APPROACHING POINT, AND CHECK POINT CODE

THIS POINT IS NOT TARGETED

LEG LENGTH (METERS)

LENGTH UNUSUALLY LONG

Figure P.4-5. PMAP Path Data Table

P.4.1.6 Path Point Table

The input path point sequence numbers are plotted on a UTM grid at points corresponding to the point locations as shown in Figure P.4-6.

P.4.1.7 Engageability Table

After plotting is complete, PMAP prints by site a list of engageable paths. A list is also generated for all paths which cannot be engaged by any sites. See Figures P.4-7 through P.4-9.

P.4.2 Annotated Output Report

The types of output generated by PMAP have been thoroughly addressed. Figures P.4-2 through P.4-9 illustrates each of these types of output. The system data table and site data tables are self explanatory. The one letter three digit grid labels on the plots are abbreviations of the UTM grid coordinate. For example the point defined at the intersection of ordinate A400 and abscissa L800 would have a UTM grid coordinate of AL400008000.

P.4.3 Output Message Definition

Several messages may be printed by PMAP in the site description table, path description table and engageability table. The messages are listed by table where they would be found.

- Site Description Table

  REMOVE THIS CARD. DUPLICATE OF THE****TH SITE - site data checking has detected two identical Type 3 cards.

  RENAME THIS SITE. SAME NAME AS THE****TH SITE FOR THIS RUN CHANGED TO - Site data checking has detected two identical site names. One of the sites was renamed.

  SITE LIES OFF AVAILABLE TERRAIN - Terrain data are not available for the site under consideration. Terrain altitude cannot be calculated.

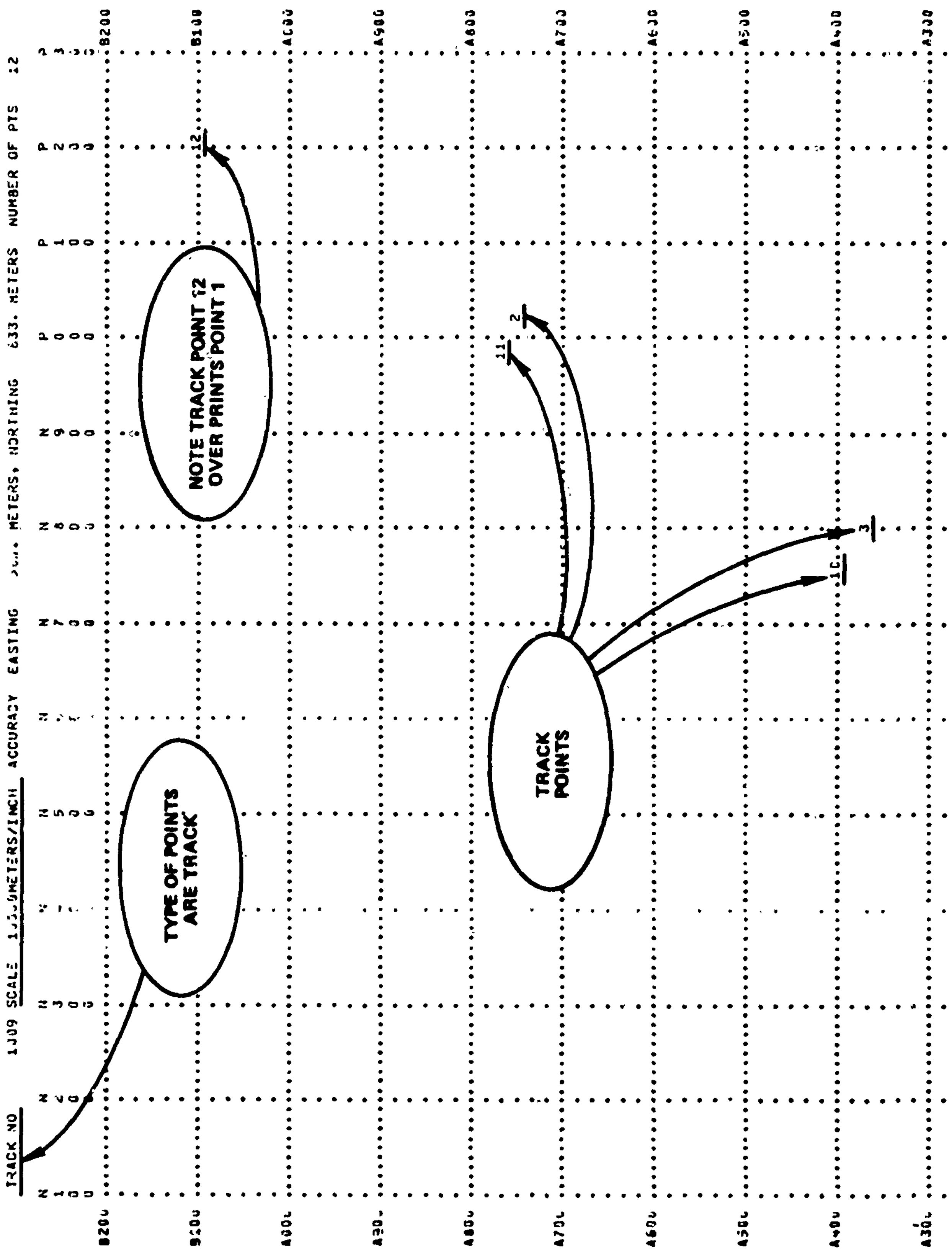

Figure F.4-6. PMAP Path Plot

Figure P.4-6. PMAP Path Plot (Continued)

```
                         E N G A G A B I L I T Y   T A B L E

NF  IDFU          IDENTIFIERS OF ENGAGABLE TRACKS

19003      1013 15007 15013
2G233       949   950  2037  2038
3H833       949   950  2037  2038
4G210       CAN NOT ENGAGE ANY OF THE TRACKS
5H833      2037
5H8-3      2038
73011      1009  1011  1013  1020  1021 94038 94039 94040 94041 94042 94043 94044 89052 89053 89054 89055 89056 89057 89058
           15005 15013 15013 15021   949   950  2037  2038
8K003      94038 94039 94040 94041 94043 89052 89053 89054 89055 89057   949   950
9K003      94038 94039 94040 94041 94043 89052 89053 89054 89055 89057   950
10M003     94038 94039 94040 94041 94043 89052 89053 89054 89055 89057   950
11M001     94038 94039 94040 94041 94043 89052 89053 89054 89055 89057   950
12M002     94038 94039 94040 94041 94043 89052 89053 89054 89055 89057   950
13A023     94038 94039 94040 94041 94042 94043 94044 89052 89053 89054 89055 89056 89057 89058 15013 15020 15021   949   950

14D025     94038 94039 94040 94041 94042 94043 94044 89052 89053 89054 89055 89056 89057 89058 15020 15021   949   950
15D027     94038 94039 94040 94041 94042 94043 94044 89052 89053 89054 89055 89056 89057 89058 15020   949   950
16D025     94038 94039 94040 94041 94042 94043 94044 89052 89053 89054 89055 89056 89057 89058 15019 15020 15021   949   950

17B01-     1009  1013  1019  1020  1021 94038 94039 94040 94041 94042 94043 94044 89052 89053 89054 89055 89056 89057 89058
           15002 15019   949   950  2037  2038
18G570      949   950
19A031     1009  1020  1021 94038 94039 94040 94041 94042 94043 94044 89052 89053 89054 89055 89056 89057 89058 15009 15019
           15020 15021   949   950
20A032     94038 94039 94040 94041 94042 94043 94044 89052 89053 89054 89055 89056 89057 89058 15019 15020   949   950
```

SITE G210 CANNOT ENGAGE ANY TRACKS

SITE IDENTIFIER

TRACK IDENTIFIERS

Figure P.4-7. PMAP Engageability Table

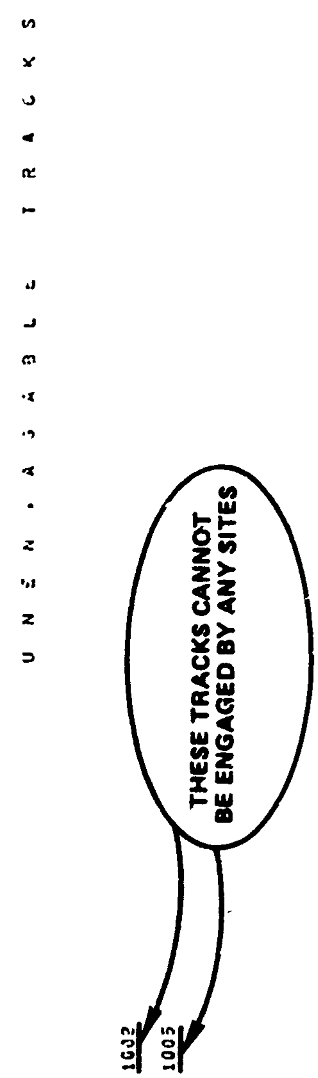

Figure P.4-8. PMAP Unengageable Path Table

TARGETED SITES AND SHORT TRACKS

NF IDFU	IDENTIFIERS OF TRACKS ENDING WITHIN VOLUME
18068	15009 15013
70011	15035 15013
13A023	15013 15020 15021
140025	15020 15021
150027	15020
160025	15009 15020 15021
170015	15032
19A031	15009 15019 15020 15021
20A032	15019 15020

SITE IDENTIFIER

TRACK IDENTIFIER

Figure P.4-9. Targeted Sites, Short Tracks and Tracks Ending Within Volume

THIS SITE IS IN A HOLE - The elevation specified for this site places the site below ground level.

- Path Description Table

UNUSUALLY LONG - This path leg exceeded the maximum spcified on Card Type 1.

+++HEAP BIG TURN=+++The turn angle at the point exceeds the maximum specified on the Type 1 card.

P.5 ERROR MESSAGE LIST

The following is an error message list for PMAP. To facilitate error lookup, the errors are categorized by the subroutine name and the statement number in the subroutine where the error was detected. Error detection sometimes generates several messages providing a trace to the source of the error. Some of the statement numbers in the computer program were not properly initialized prior to error message printing. These statement numbers are listed as 'XXXX'. For those errors that can usually be corrected by the analyst, the suggested corrective action is shown following the error or errors for which the corrective action applies.

ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
ABSCØR	XXXX	The abscissa coordinate values extend past 132 spaces at the specified spacing.
	XXXX	An illegal grid letter was returned by CNL.
LABEL	XXXX	CNL cannot find a valid grid letter corresponding to the easting under consideration. - CORRECTIVE ACTION - Check the input sites and/or path point locations to determine the site/point which required the invalid grid letter. Correct this site location.
MAIN	1100	An illegal grid square designator has been specified for the coordinate system origin. - CORRECTIVE ACTION - Insert the valid grid zone designator and corresponding UTM grid square designator on Card Type 1.
	1250	An I/Ø parity error was detected in an attempt to read the dispatch card from file 8.
	3000	An out of sequence card or end-of-file was encountered in an attempt to read the second copy of the SITE type card from file 8.
	3010	An I/Ø parity error was detected in an attempt to read the second copy of the SITE card from file 8. - CORRECTIVE ACTION - This error occurs during reading the input records from the secondary input device. Parity errors can usually be corrected by standard "clean-up" techniques (such as cleaning the tape and read heads). Erroneous EØF's require a more detailed look at ways these might have been generated by the secondary input device.
	3080	The number of sites entered exceeds the maximum allowable (255). - CORRECTIVE ACTION - Reduce the number of SITE cards input to 255.
MAP	4015	An I/Ø parity error was detected in an attempt to read the second copy of the TRACK type card from file 8.
	4016	An end-of-file was encountered in an attempt to read the second copy of the TRACK type card from file 8.

ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
MAP (Cont'd.)	5001	An I/Ø parity error was detected in an attempt to read the second copy of the PØINT type card from file 8.
	5002	An end-of-file was encountered in an attempt to read the second copy of the PØINT type card from file 8.
		- CORRECTIVE ACTION -
		Refer to the corrective action suggested for MAIN 3010.
MAP	2000	ABSCØR is unable to generate the required abscissa labels.
	2990	LABEL is unable to generate the ordinate labels.
		- CORRECTIVE ACTION -
		Check the input sites and/or path point locations to determine the site/point which required the invalid grid letter.

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CHAPTER SØRTEV

SØRTEV USER/PLANNER GUIDE

S.1 DETAILED DESCRIPTION OF MODULE FUNCTION

SØRTEV is a CDC 6600 computer program forming part of the TACOS II model. It is a postprocessing program designed to select and reorder (sort) battle history events produced by the Monte Carlo simulation portion, FRAG3, and recorded in its output history data set. The printed battle history produced by FRAG3 represents occurrences in the simulated air defense battle on a totally time-ordered basis. SØRTEV was constructed to relieve personnel responsible for analyzing TACOS output of the tedium of extracting the history of operation of a given air defense site or cell of penetrating penetrators from the bulk of the histories of all other sites or cells.

The basic concept of SØRTEV is to select events from a FRAG3 history tape (data set), pass them to the CDC supplied COBOL Sort program, receive then in a new sequence from Sort, translate them into legible line images, and to print them. This process is flowcharted in Figure S.1-1.

S.1.1 Submodels Used

Only two submodels are used in SØRTEV: SØRSEV and PRTSEV.

S.1.1.1 Submodel SØRSEV

SØRSEV is a COMPASS language routine which utilizes the CDC 6600 supplied COBOL SORT/MERGE program to sort any events supplied to it on input unit TAPE16. The sorted events are output on unit TAPE18 for further use by SØRTEV.

S.1.1.2 Submodel PRTSEV

PRTSEV is a FORTRAN language subroutine which accepts sorted events from SØRTEV and translates them into appropriate line images. It also creates matching header information before printing the sorted events.

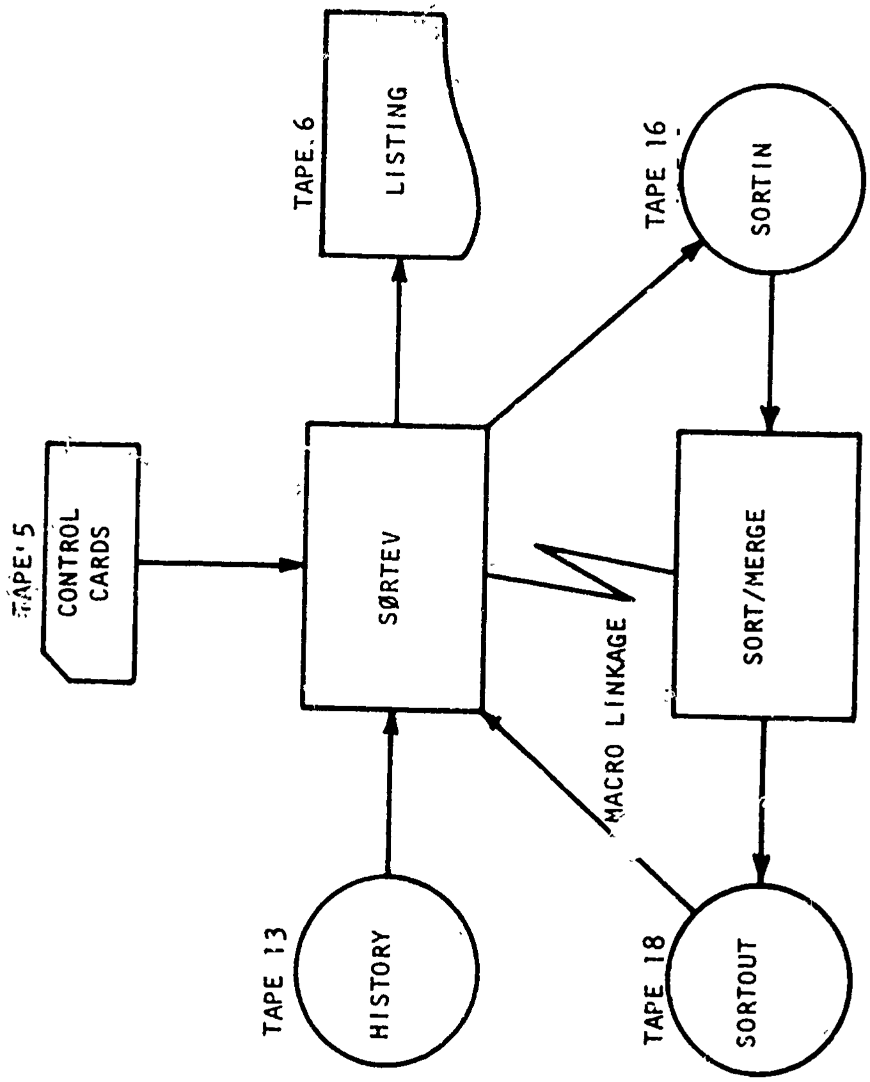

Figure S.1-1. Data Flow in Program SØRTEV

S.1.2 Run Resources Required

SØRTEV requires the following resources for running:

- CDC 6600 with at least a 44800 word (decimal) region available.
- Three file access devices. These are to access the FRAG3 history file, and two files for use by the CDC SORT/MERGE program.
- Random access mass storage also for use by the CDC SORT/MERGE program.
- Input cards describing the type of sort and detailing the sites or cells to be sorted.

S.2 DATA REQUIREMENTS

SØRTEV requires, as primary data input, the history tape output by FRAG3 for the situation under analysis. The tape format is detailed in Volume IID.

S.2.1 Card Type Functional Definitions

In order to perform a sort on a FRAG3 history tape, SØRTEV expects control parameters to be input on two different types of cards: Type 1 and Type 2.

S.2.1.1 Type 1 Cards

Four parameters are set by variables defined on a Type 1 input card:

- Type of sort - site, cell, or coordinate (location partition)
- First replication to be sorted
- Last replication to be sorted
- Event subset to sort - all, missile expending, or kills only.

If a site sort is to be performed on a set of sites not encompassing all sites in the deployment, or if a cell sort is to be performed on a set of cells not encompassing all cells in the penetration, then those sites or cells for which sort listings are desired must be identified to SØRTEV. This identification is performed by a Type 2 input card.

S.2.1.2 Type 2 Cards

A Type 2 card identifies the subset of sites or cells for which to sort. (If all sites or cells are to be sorted, then no Type 2 card is input.) Since only 16 sites or cells can be identified on a single occurrence of a Type 2 card, SØRTEV allows the user to input as many of this type of card as is necessary to enumerate the sites or cells desired. SØRTEV does require that, if more than one Type 2 card is used to enumerate ID's, all but the last have all 16 fields used.

S.2.2 Input Data Deck Sequencing

Figure S.2-1 illustrates the data deck sequences for different runs of SØRTEV. Figure S.2-1a shows a single sort deck setup. SØRTEV has what may be called a batching capability. That is, more than one sort can be run in a single execution of program SØRTEV. This can be accomplished by supplying a Type 1 Card (and its associated Type 2 cards, if necessary) for each sort desired from the FRAG3 history tape used for "this" execution of SØRTEV. This is shown in Figure S.2-1b. Only one FRAG3 history tape (data set) can be specified for a single SØRTEV run.

S.2.3 Input Variables Definitions, Usages, Interactions, and Formats

This paragraph contains a detailed description of each SØRTEV input card in tabular form. The information presented includes the card type numbers, the conditions under which the card is (or is not) read, the variable names into which the data are read, the card columns into which the data must be punched, the permissible range of its values, the type and FORTRAN format of each variable and their descriptions. The column for interaction contains the section number where the interaction is described. Finally, notes on card and variable usage are included.

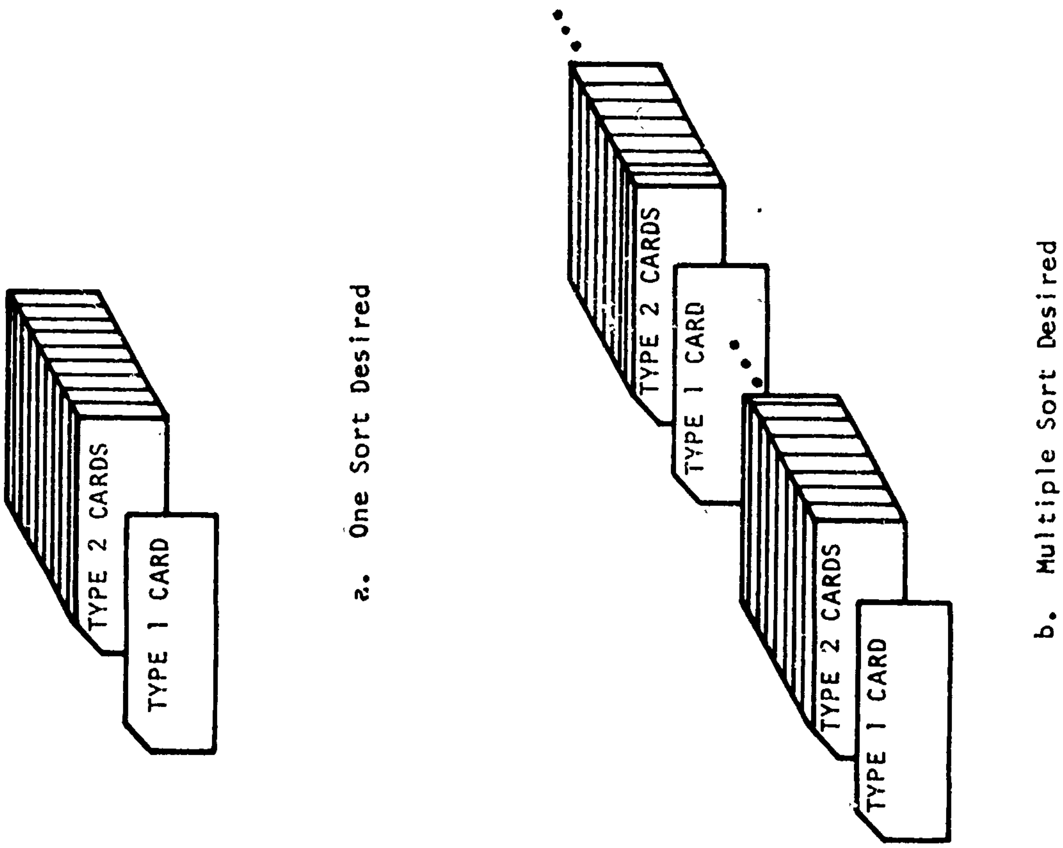

Figure S.2-1. SØRTEV Data Deck Sequencing

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TACOS PROGRAM: SØRTEV | CARD TYPE: 1 | FUNCTIONAL USE: To input Sort parameters

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: Card Type 1 is read for each sort procedure desired.

VARIABLE NAME	CARD COLUMNS	VARIABLE RANGE	CARD FORMAT	INTERACTIONS	VARIABLE DESCRIPTION
IØP	1-4	N.A.	A4		'SITE' for a site sort 'CELL' for a cell sort 'CØØR' for a location partition sort
NU	11-15	0-255	I5		Integer specifying the number of site or cell identifiers supplied on immediately succeeding Type 2 cards. If zero or blank is coded, then SØRTEV assumes all sites or cells are to be included in the sort and that no Type 2 cards follow this Type 1 card.
NFST	16-20	1-9999	I5		Integer specifying the sequence number of the first replication for which sorted events are desired. The first replication is Number 1.
NREPD	21-25	1-9999	I5		Integer specifying the sequence number of the last replication for which sorted events are desired.
ZEV	30	T or F	Z4		A pair of logical flags specifying the subset of event types for which the sort is desired.

BDM/A 480-10-73

TACOS PROGRAM: SØRTEV | **CARD TYPE:** 1 (Cont'd) | **FUNCTIONAL USE:** To input Sort parameters

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: Card Type 1 is read for each sort procedure desired.

VARIABLE NAME	CARD COLUMNS	VARIABLE RANGE	CARD FORMAT	INTERACTIONS	VARIABLE DESCRIPTION
ZKØ	35	T or F	Z4		Col 30 Col 35 F F all events T F missile expending events T T kills only F T all events with pagination suppressed - not recommended for general use.

NOTE: Integers must be right justified in their card fields.

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TACOS PROGRAM: SØRTEV | **CARD TYPE:** 2 | **FUNCTIONAL USE:** To input Site or Cell names

CONDITIONS UNDER WHICH CARD IS (OR IS NOT) READ: Card Type 2 is used to input site or cell names for which a sort is desired. If NU on card Type 1 is input as "0", no Card Type 2 is used.

VARIABLE NAME	CARD COLUMNS	VARIABLE RANGE	CARD FORMAT	INTERACTIONS	VARIABLE DESCRIPTION
ID	1-4 6-9 11-14 16-19 21-24 26-29 31-34 36-39 41-44 46-49 51-54 56-59 61-64 66-69 71-74 76-79	N.A.	A4	S.4.SØRTEV-8 VOL II D	16 4-character fields containing site or cell identifiers specifying the subset of sites or cells desired for a site or cell sort. As many Type 2 cards as necessary may follow a Type 1 which implies site or cell subset. Fill all 16 fields on a Type 2 card before going on to the next Type 2 card. Make sure that the used fields on the last Type 2 card of a set start at the beginning of the card with no blank fields interspersed.

NOTE: A blank is a valid character when it comes to character fields. 'ƀABC' is different from 'ABCƀ'.

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S.2.4 Relationship of Input Variables to Influenced Submodels

As noted previously there are only two submodels in SØRTEV. They are described in the following subparagraphs:

S.2.4.1 Submodel SØRSEV

SØRSEV is a COMPASS language routine which utilizes the CDC 6600 supplied COBOL Sort to sort any events supplied to it on input unit TAPE16.

S.2.4.1.1 Input Variables Affecting This Submodel

The call structure for SØRSEV is:

CALL SØRSEV(NZ), RETURNS(A1)

NZ is an integer variable which is deduced from the input variable IØP. If IØP is input as SITE then NZ = 1; if IØP is input as CELL then NZ = 2; and if IØP is input as CØØR then NZ = 3. SØRSEV uses NZ as the key upon which input variables are to be sorted.

S.2.4.1.2 Examples of Inputs and Their Effects

IØP can only have three possible variations: SITE, CELL, and CØØR. Inputting SITE causes a sort for selected sites. Inputting CELL causes a sort for selected cells. Inputting CØØR causes a series of sorts of events in 100 km^2 squares of the battle area. Examples of outputs for these various sorts are given in Section S.4.2.

S.2.4.2 Submodel PRTSEV

PRTSEV is a FORTRAN EXTENDED language subroutine which accepts sorted events from SØRTEV and causes them to be printed in standard TACOS FRAG3 history output.

S.2.4.2.1 Input Variables Affecting This Submodel

The call structure for PRTSEV is:

CALL PRTSEV(KØ,NZ) ,RETURNS(A1)

KØ is an integer variable which is deduced from whether or not there is more than one Card Type 1 input and if the previous events read from TAPE16 can be used for this sort. If this is true, then KØ = 1. NZ was previously described in Subparagraph S.2.4.1.1.

S.2.4.2.2 Examples of Inputs and Their Effects

NZ and its relation to IØP have already been described in Subparagraph S.2.4.1.2. PRTSEV is the means by which the sample listings described in Paragraph S.4.2 are produced.

S.2.5 Input Conventions

S.2.5.1 General

The following conventions are used within the TACOS II input descriptions.

CHARACTERS	CONVENTION
Letters - o	Ø
i	I
Numbers - 0	0
1	1
Blank - (space)	ƀ

LOGIC

Implication (ØRDER)	→

For example: 'SITE' → Site sort

Explicit characters to be input in prescribed data fields appear within single quotation marks; e.g., 'ƀTRK'.

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S.2.5.2 FORTRAN Codes

The general FORTRAN input format codes are:

aIw	Integer data fields.
aFw.d	Real (floating point) data field.
aEw.d	Real (floating point) data field.
aOw	Octal data field.
aIw	Logical data field.
aAw	Alphanumeric data field.
wX	Indicates that a field is to be skipped.
a(...)	Indicates a group format specification.

where: a is optional and is an unsigned integer constant used to denote the number of times the format code is to be used. If a is omitted, the code is used only once.

w is an unsigned integer constant specifying the number of characters of data in the field.

d is an unsigned integer constant specifying the number of decimal places to the right of the decimal point, i.e., the fractional portion.

(...) within the parentheses are format codes separated by commas. The a preceding this form is the group repeat count.

S.2.5.2.1 Integer Data Field Notes

Do not use special or alphabetic characters; i.e., letters A to Z, periods (.), slashes (/), @, decimal point, etc.

A blank field is considered to be zero; i.e., same as entering '0' in that field.

All data should be right justified within the field. If the data are not right justified within the field, the remaining fields to the right of the actual data will be filled with significant zeroes.

S.2.5.2.2 Real (Floating Point) Data Field Notes

A decimal point need not be provided in the data; however, the program will assume the decimal point is located as indicated in the format code; e.g., format code F4.2 and input data right justified 199 will be interpreted as 1.99.

Do not use special or alphabetic characters; i.e., letters A to Z, $, @, etc. A decimal point (.) and a minus sign (-) are valid.

If a decimal point is to be input in a field, its position overrides the position indicated by the d portion of the format code and the positions reserved by w must include a place for the decimal point.

Leading, embedded, and trailing blanks in the field are interpreted as zeroes.

For very large numbers, the number can be input through the use of decimal exponents, i.e., powers of 10. This is done by following the desired significant figure (with the decimal point anywhere in the figures) with the letter "E" and the appropriate power of 10. For example:

1300000000000000000000.

may be written as

1.3E+21 or .13E+22 or 1.3E21.

.0000000000000000000009

may be written as

.9E-19 or 9.E-20

The exponent field is treated as an integer and must be right justified in the field; otherwise, trailing blanks are interpreted as zeroes.

S.2.5.2.3 Octal Data Field Notes

Octal digits have the following correspondence to decimal numbers:

0	1	2	3	4	5	6	7	10	11	12
|	|	|	|	|	|	|	|	|	|	|
0	1	2	3	4	5	6	7	8	9	10

They are used to set random number bases or to serve through their internal binary representation as a series of on/off switches.

S.2.5.2.4 Logical Data Field Notes

They are used for input of logical decisions; TRUE or FALSE.

The first T or F encountered (reading left to right) in the logical data field causes a value of TRUE or FALSE, respectively.

All blanks in the field are interpreted as FALSE.

S.2.5.2.5 Alphanumeric Data Field Notes

Any alphabetic or special character may be used in this type of field.

Numbers may be used within this field and they are considered as characters.

A blank (b̸) is a character and has the same validity as the other characters.

All alphanumeric identifiers of entities and entity characteristic categories are arbitrary.

S.3 RUN DECK SETUP

The MICOM version of TACOS II was designed to be run on a CDC 6600 with an operating system of Scope 3.4. This section describes the control cards to be used for a typical run. Also, examples of various combinations of input control cards are given.

S.3.1 Typical Control Card Setup

The data requirements and formats for SØRTEV have been thoroughly discussed in previous sections. It remains only to show an example of a typical run which was made on the MICOM computer. This is shown in Figure S.3-1. All control and request cards are shown, as well the relative locations of FORTRAN and data decks. In order to show the reader what is required for compilation, the example setup is for both compile and run.

S.3.2 Input Data Deck Example

Sample input control cards are shown in Figures S.3-2 through S.3-4. These three examples show the various types of sorts which are available through the use of SORTEV.

```
JOB CARD
ACCTNG CARD
REQUEST(TAPE13,[illegible]Y)      [illegible]040[illegible]0   NORING
FILE(TAPE1[illegible],[illegible]T=[illegible],[illegible]T=[illegible],[illegible]L=170)
FILE(TAPE1[illegible],[illegible]T=[illegible],[illegible]T=[illegible],[illegible]L=170)
FTN(S=S[illegible]TEXT,S=[illegible]TEXT)
MAP(ON)
RFL(200000)
LDSET(L[illegible]=[illegible]/[illegible])
LDSET(FILES=TAPE1[illegible]/TAPE1[illegible])
LGO.
&
          .
          .
          .
     - FORTRAN [illegible] -
          .
          .
          .
&
          .
          .
          .
     - DATA CARDS -
          .
          .
          .
&
#
```

NOTE:

& = 7/8/9 punch

= 6/7/8/9 punch

Figure S.3-1. Sample SØRTEV Deck Setup

card columns

	1	15	20	25	30	35
	↓	↓	↓	↓	↓	↓
Type 1 Card	CELL	5	2	3	T	F

	1	6	11	16	21
	↓	↓	↓	↓	↓
Type 2 Card	A207	A208	B372	B373	UA27

This control card setup will produce a listing (by cell) of all shots fired at cells A207, A208, B372, B373, and UA27 during replications 2 and 3.

Figure S.3-2. SØRTEV Control Card Example 1

card columns

	1	15	20	25	30	35
	↓	↓	↓	↓	↓	↓
Type 1 Card	SITE	0	1	5	F	F

No Type 2 control card allowed. All events from replications 1-5 will be listed, sorted first by replication, second by site, and third by time. Events for all sites will be printed.

Figure S.3-3. SØRTEV Control Card Example 2

card column

	1	15	20	25	30	35
	↓	↓	↓	↓	↓	↓
All Type 1 Cards	SITE	0	1	5	T	T
	CELL	0	1	5	T	T
	CØØR	0	1	5	T	T

All kill events will be listed first, by replication, site and time; second, by replication, cell, and time; and third by replication, location partition, and time. The input tape is read just once because the same subset of events is used for each sort.

Figure S.3-4. SØRTEV Control Card Example 3

S.4 OUTPUT DATA DEFINITIONS

S.4.1 Output Report Sequencing

S.4.1.1 Flowchart

The sequence of output reports depends on the order in which the user inputs sort control cards. The general logic flowchart for output sequencing is shown in Figure S.4-1.

S.4.1.2 Sort Types

SØRTEV produces history listings sorted on three different major keys as selected by the user. These keys are:

- Site identifier.
- Cell identifier.
- Location partition

Each of these three types of sorts has, as a "super-major" key, the Monte Carlo replication number and, as a minor key, the time of occurrence of the event. This implies that the structure of a site sort listing (for example) would be as illustrated in Figure S.4-2. Let us consider the listing produced in the sorting of events for a single replication. If the sort is by site, then all the events describing the activity of a given site are listed in a group, in time sequence, with no events describing any other site interspersed. Similarly, a cell sort produces histories of what happened to each penetrator cell, cell by cell and in time sequence. Finally, the location partition sort produces listings of events indexed on a 10 by 10 kilometer square where the event occurred, square by square, scanning the area in which the battle occurs in a fashion akin to a television raster rotated 90°. Figure S.4-3 is illustrative of this concept. All events occurring in Square 1 are listed first, those occurring in Square 2 are listed second, etc. Within each square, the events are listed in time sequence.

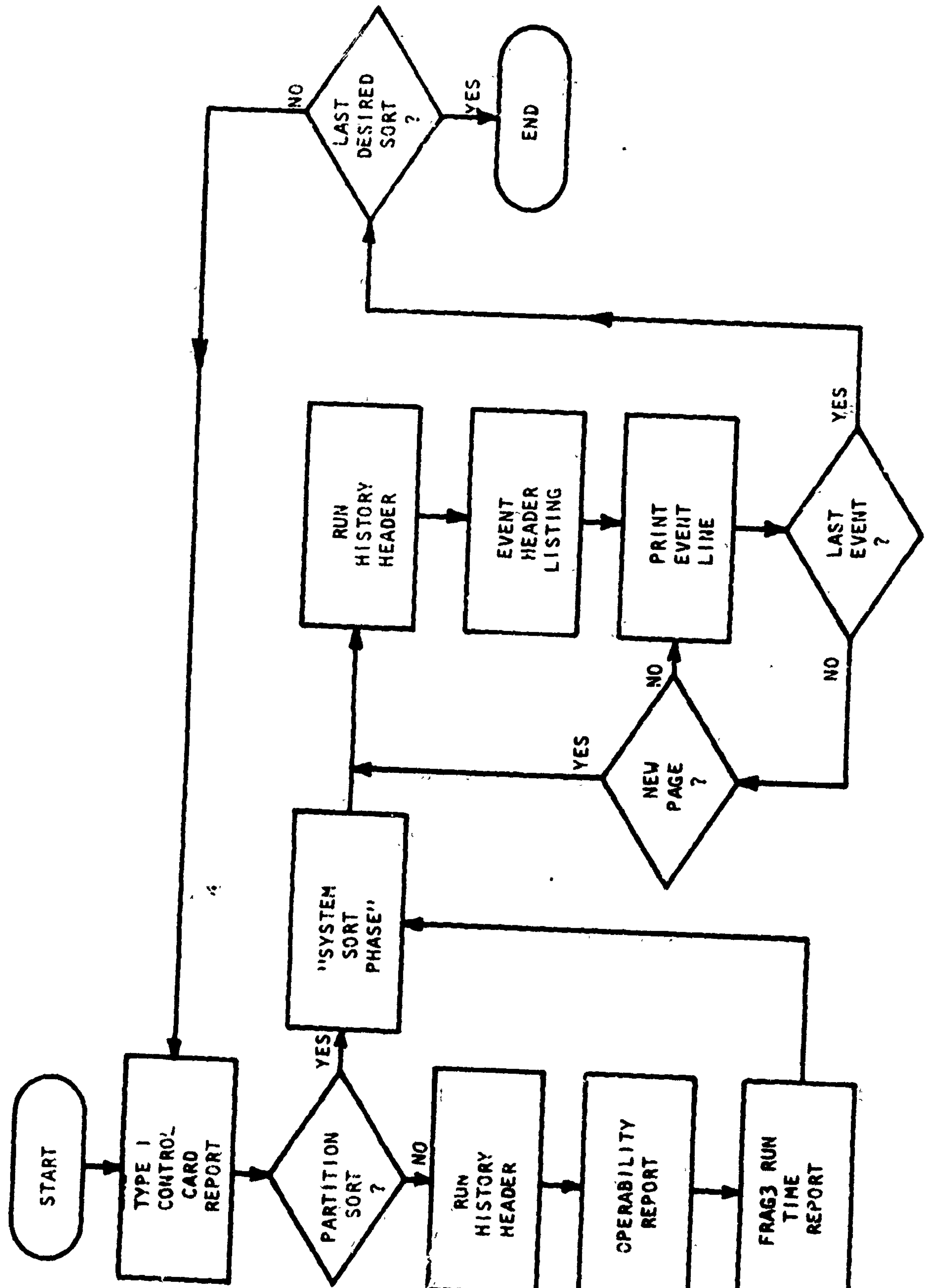

Figure S.4-1. Output Report Sequencing Flowchart

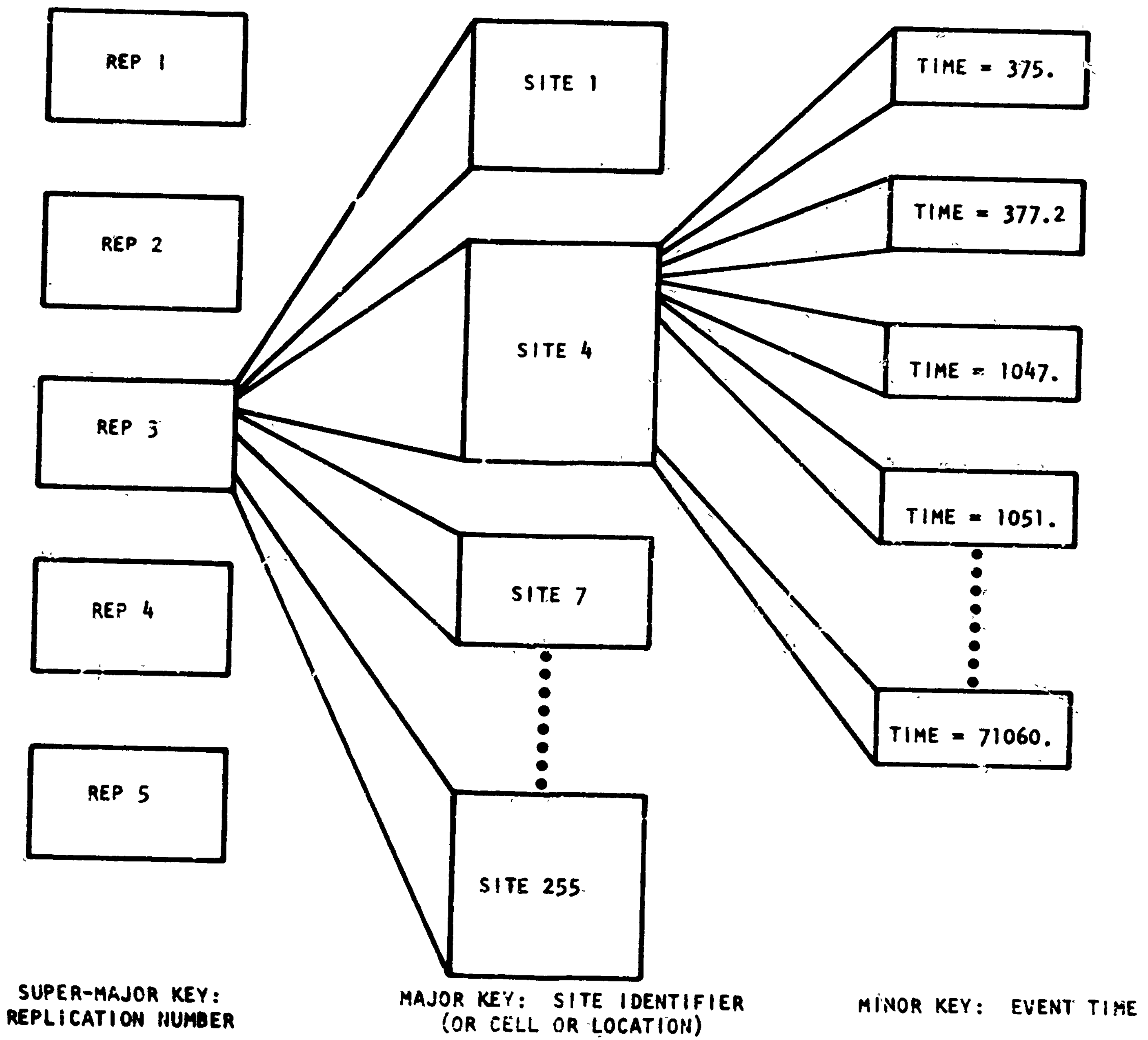

Figure S.4-2. Sorting Hierarchy-Structure of a Site Sort Listing

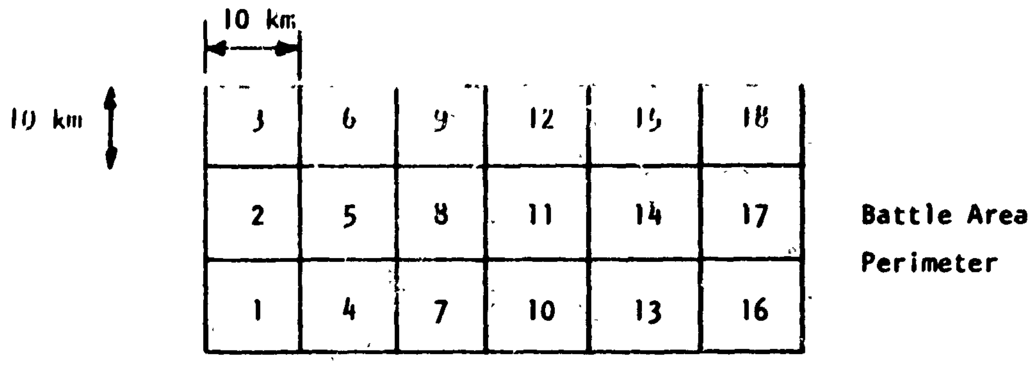

Figure S.4-3. Location Partition Sort Sequence

S.4.1.3 Event Subset

In addition to the sorting capability, an event subset selection capability is available in SØRTEV. The three selections available are:

- All events.
- Results of ordnance launches.
- Kills only.

Events representing the results of ordnance launches (missile expending events) include kills, misses (non-kill random numbers), and aborts for whatever reason.

S.4.2 Annotated Output Report

S.4.2.1 Output Page Types

For each sort desired, the output consists of at least two page types. For a location partition sort, the first page type is merely an echo of the information input on the Type 1 card. The second page type contains the desired sorted event data. An example of these pages is shown in Figures S.4-4 and S.4-5. For site and cell sorts, a page for site operability reports is inserted between the two pages described above. Examples of these pages are given in Figures S.4-6 through S.4-11.

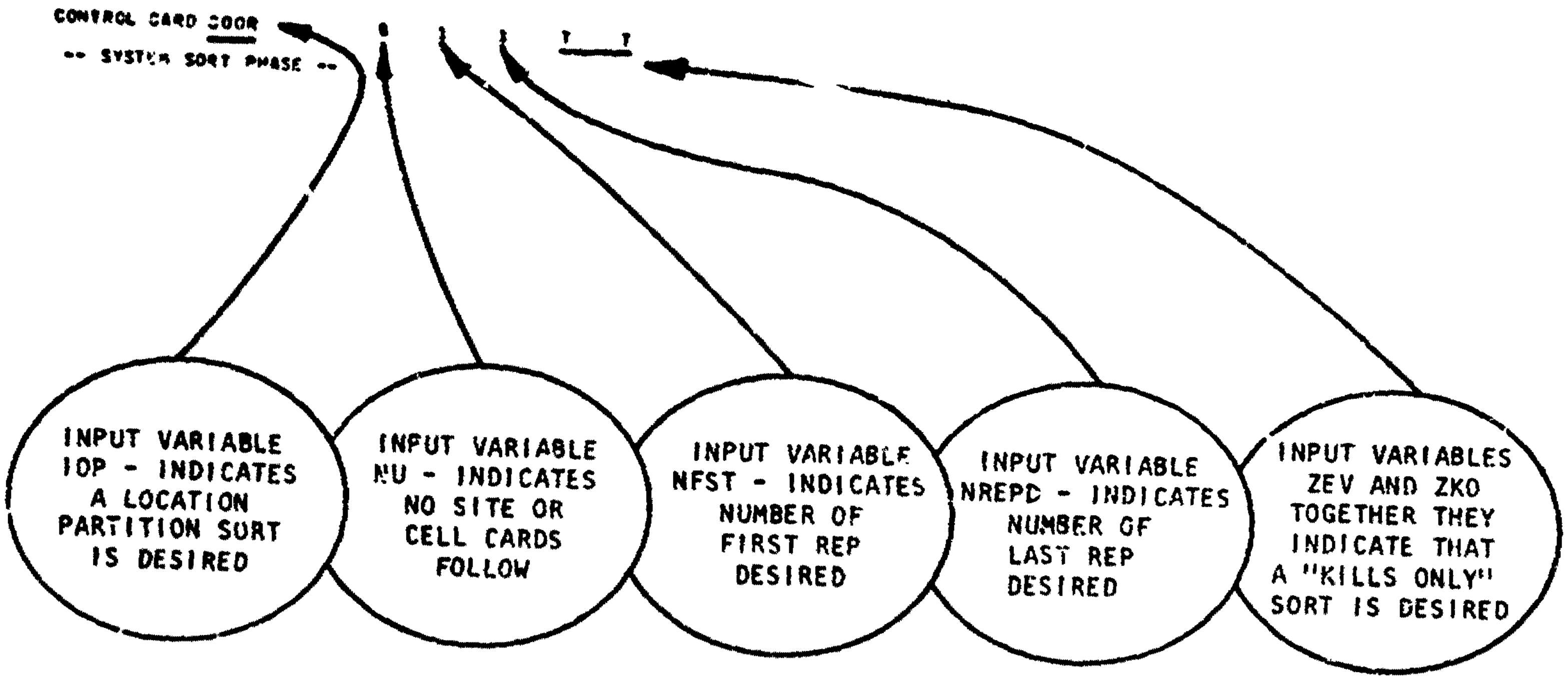

Figure S.4-4. Example of Location Partition Sort - First Page

CADWAG

DEPLOYMENT DATA

05/21/73 20.33.39. RUN - 1 F3 TEST 2.5

05/18/73 20.42.29. 07/03/73 08.20.08.

CELL	SBJT	TRK	FIRE UNIT	MSLS FIRED	EVENT TIME	TIME TWO	RANGE	EVENT COORDINATES	ALT	WAITING LIST	RESULT
C037	2	2037	SYMBM038	62000	1451.90	1444.92	2500.	NA49006147	373.	000000	T-V KILLED ************
C038	2	2038	SYMB4038	62000	1491.90	1484.90	2500.	NA49006147	373.	000606	T-V KILLED ************
A949	2	949	SYMBM038	62000	2509.73	2504.63	1446.	NA90326067	362.	000000	T-V KILLED ************
A950	2	950	SYMBM038	62000	2566.73	2561.63	1446.	NA90326067	362.	000000	T-V KILLED ************
C038	1	2038	SYMBM049	96420	1599.17	1593.27	1090.	NA84264677	272.	000000	T-V KILLED ************

Figure S.4-5. Example of Location Partition Sort - Second Page

```
CONTROL CARD SITE        8   1   1   7   7
```

INPUT VARIABLE
IOP - INDICATES
A SITE SORT IS
DESIRED

Figure S.4-6. Example of Site Sort - Kills Only - First Page

```
CADMAG                                                        05/21/73  20.53.39.             F3 TEST 2.5
DEPLOYMENT DATA                                               05/10/73  20.42.29.              07/03/73  08.20.36.

                  RUN -    1               OPERABILITY REPORT             RANDOM NUMBER BASE 300000C00C000000105

     SYMBM830  ALIVE      SYMBM033  ALIVE      SYMBM849  ALIVE      SYGBG210  ALIVE      SYGBG233  ALIVE
     SYGBG570  ALIVE      SYKBK008  ALIVE      SYK3K009  ALIVE      SYMCM001  ALIVE      SYMBM002  ALIVE
     SYMBM083  ALIVE      SYAAA021  ALIVE      SYAAA031  ALIVE      SYAAA032  ALIVE      SYBAB004  ALIVE
     SYBAB011  ALIVE      SYBAC015  ALIVE      SYMOO025  DEAD       SYMOO026  DEAD       SYMOO027  ALIVE
RUN TIME WAS        0.03
 -- SYSTEM SORT PHASE --
```

INDICATES DESIRED
EVENTS HAVE BEEN
FOUND AND TIME
SORTING HAS BEGUN

REP EXECUTION
TIME REPORT
IN THIS CASE
TIME WAS LESS
THAN 99 MILLISECONDS

Figure S.4-7. Example of Site Sort - Kills Only - Second Page

CAGWAG 05/21/73 20.53.39. RUN - 1 F3 TEST 2.5

DEPLOYMENT DATA 05/18/73 23.42.29. 07/03/73 08.20.08.

CELL	OBJT	TRK	FIRE UNIT	MSLS FIRED	EVENT TIME	TIME TWO	RANGE	EVENT COORDINATES	ALT	WAITING LIST	RESULT
C037	2	2037	SYMB4833 62000		1491.90	1446.90	2500.	NA8900D147	373.	000003	T-V KILLED ************
C038	2	2038	SYMB4833 62000		1491.30	1486.90	2500.	NA89D06147	373.	003000	T-V KILLED ************
A949	2	949	SYMB4833 62000		2509.73	2504.61	1446.	NA9C12E067	362.	000000	T-V KILLED ************
A950	2	950	SYMB4833 62000		2566.73	2561.63	1446.	NA9C32EC67	362.	060000	T-V KILLED ************
C038	1	2038	SYMB4949 56420		1599.17	1591.77	1593.	NA8624A277	272.	303000	T-V KILLED ************

Figure S.4-8. Example of Site Sort - Kills Only - Third Page

CONTROL CARD CELL 0 1 1 1 1

INPUT VARIABLE
IOP - INDICATES
A CELL SORT IS
DESIRED

Figure S.4-9. Example of Cell Sort - Kills Only - First Page

```
CADWAG                                              05/21/73  20.53.39.         F3 TEST 2.5
DEPLOYMENT DATA
                                                    05/18/73  20.42.29.          07/03/73  08.20.08.
                   RUN -   1            OPERABILITY REPORT            RANDOM NUMBER BASE 0000000000000000105
     SYHCH838  ALIVE      SYHBH833  ALIVE      SYH3H849  ALIVE      SYGBG210  ALIVE      SYGBG233  ALIVE
     SYGBG570  ALIVE      SYKBK888  ALIVE      SYK3K009  ALIVE      SYHCH001  ALIVE      SYHBH002  ALIVE
     SYHBH883  ALIVE      SYAAA029  ALIVE      SYAAA031  ALIVE      SYAAA032  ALIVE      SYBAB008  ALIVE
     SYBAB011  ALIVE      SYBAB015  ALIVE      SYHDD025  DEAD       SYHDD026  DEAD       SYHDD027  ALIVE
RUN TIME WAS      0.00
 -- SYSTEM SORT PHASE --
```

Figure S.4-10.   Example of Cell Sort - Kills Only - Second Page

CADWAG 05/21/73 20.53.39. RUN - 1 F3 TEST 2.5

DEPLOYMENT DATA 05/18/73 20.42.29. 07/03/73 08.20.88.

CELL	OBJT	TRK	FIRE UNIT	MS_S FIRED	EVENT TIME	TIME TWO	RANGE	EVENT COORDINATES	ALT	WAITING LIST	RESULT
C037	2	2037	SYMBM830	62008	1451.90	1444.90	2500.	NA89006147	373.	000000	T-V KILLED ************
C038	2	2038	SYMB4830	62000	1491.90	1484.90	2500.	NA89006147	373.	000000	T-V KILLED ************
A949	2	949	SYMB4830	62000	2509.73	2504.63	1446.	NA90326067	362.	000000	T-V KILLED ************
A950	2	950	SYMBM830	62000	2566.73	2561.63	1446.	NA90326067	362.	000000	T-V KILLED ************
C038	1	138	SYMBM849	56420	1599.17	1593.27	1890.	NA84264077	272.	000000	T-V KILLED ************

Figures S.4-11. Example of Cell Sort-Kills Only-Third Page

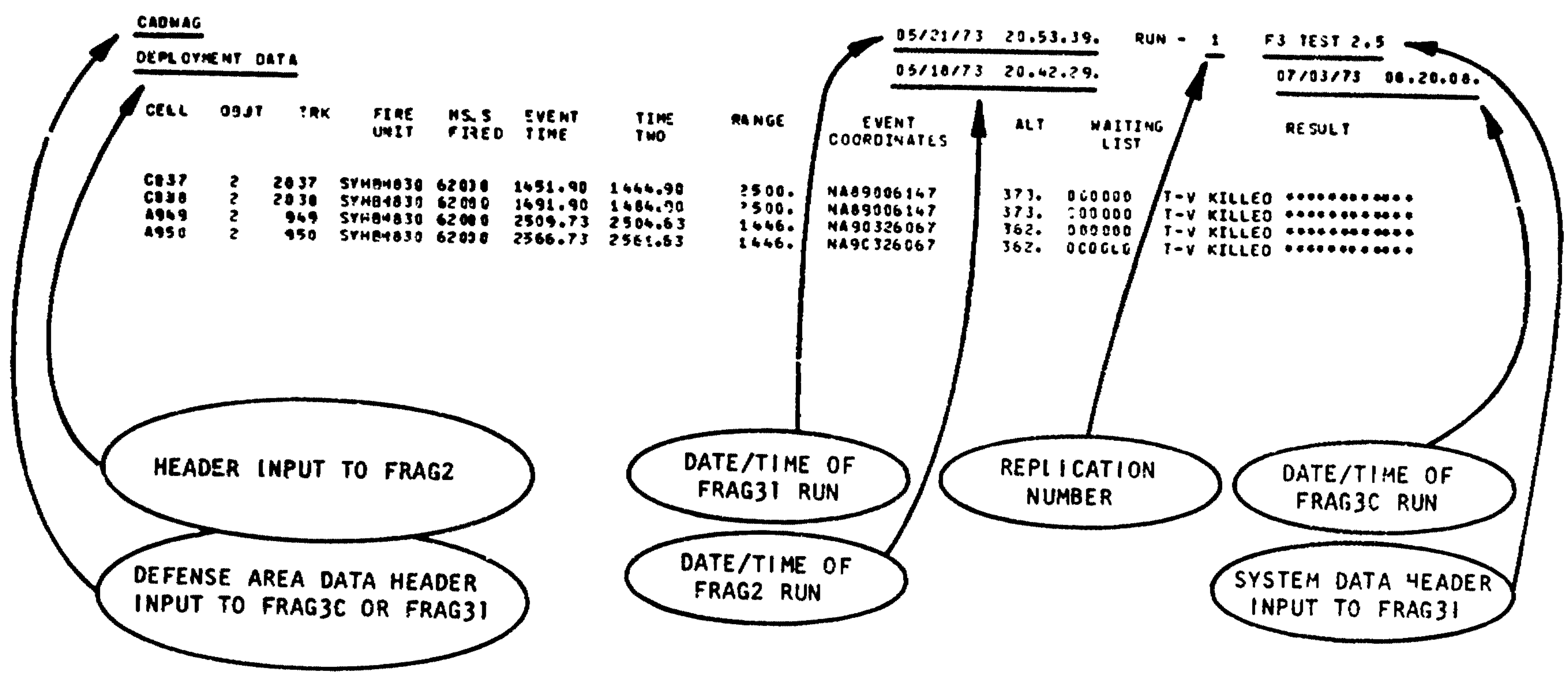

Figure S.4-12. Explanation of Heading Fields

S.4.2.2 Output Page Headings

The first two lines of printed output on each page of sorted event listings identify the FRAG2, FRAG31, and FRAG3C runs that were used to create the history tape input to SØRTEV. In addition, the replication number for which events are printed is given in this heading. Figure S.4-12 identifies each of the fields in the heading and its source.

S.4.3 Output Message Definition

Each column in the output is identified with a heading. Most of the fields represent the same thing for differing event types. Only a very condensed explanation of variable-meaning fields is provided here in that this output is almost identical with FRAG3.

CELL - cell identifier as input in FRAG2.

ØBJT - object number in cell or number of objects in cell.

TRK - identifier of flight path which the cell is traversing.

FIRE UNIT - identifiers of the system type and site.

MSLS FIRED - missile sequence number in salvo or total number of missiles committed or kill probability (X1000).

EVENT TIME - time when event occurred.

TIME TWO - Time when preceding or following event in this sequence occurred or is to occur.

RANGE - slant range from site to cell at time of event.

EVENT COORDINATES - cell location at time of event or site location.

ALT - altitude of cell above MSL at time of event or site altitude.

WAITING LIST - always zeroes.

RESULT - message describing event.

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S.5 ERROR MESSAGE LIST

The accompanying tables show all the error conditions which could cause an error printout during execution of SØRTEV. The format of the printout is:

ERROR FROM STATEMENT NUMBER_____ IN SUBROUTINE _____.

To utilize the tables, the user finds the subroutine referenced, then locates the statement number. The tables have, for each statement number, both an explanation of the condition most likely to cause the error printout and suggested action to correct the condition.

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ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
RDFST	1000	End-of-file or parity error encountered while reading common block SYHD on tape unit 13.
	1002	End-of-file or parity error encountered while reading common block SY01 on tape unit 13.
	1004	End-of-file or parity error encountered while reading common block SY02 on tape unit 13.
	1006	End-of-file or parity error encountered while reading common block SY03 on tape unit 13.
	1010	End-of-file or parity error encountered while reading common block RD01 on tape unit 13.
	1012	End-of-file or parity error encountered while reading common block MS01 on tape unit 13.
	1016	End-of-file or parity error encountered while reading common block TV01 on tape unit 13.
	1018	End-of-file or parity error encountered while reading common block TV02 on tape unit 13.
	1020	End-of-file or parity error encountered while reading common block TV03 on tape unit 13.
	1022	End-of-file or parity error encountered while reading common block DAHD on tape unit 13.
	1024	End-of-file or parity error encountered while reading common block FU01 on tape unit 13.
	1026	End-of-file or parity error encountered while reading common block CE01 on tape unit 13.
	1028	End-of-file or parity error encountered while reading common block CE03 on tape unit 13.
	1030	End-of-file or parity error encountered while reading common block CV1 on tape unit 13.
	1032	End-of-file or parity error encountered while reading common block QMFD on tape unit 13.
	1034	End-of-file or parity error encountered while reading common block QSAP on tape unit 13.
	1036	End-of-file or parity error encountered while reading common block QSA on tape unit 13.
	1038	End-of-file or parity error encountered while reading common block QQN1 on tape unit 13.
	1040	End-of-file or parity error encountered while reading common block QQN2 on tape unit 13.

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ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
RDF*T (Cont'd)	1042	End-of-file or parity error encountered while reading common block QQN3 on tape unit 13.
	1044	End-of-file or parity error encountered while reading common block ECMA on tape unit 13.
	1046	End-of-file or parity error encountered while reading common block ECMB on tape unit 13.
	1052	End-of-file or parity error encountered while reading common block TV05 on tape unit 13.
	1054	End-of-file or parity error encountered while reading common block GUN on tape unit 13.
	1056	End-of-file or parity error encountered while reading common block LLNK on tape unit 13.
	1058	End-of-file or parity error encountered while reading common block FAHC on tape unit 13.
	1060	End-of-file or parity error encountered while reading common block FAHD on tape unit 13.
	1062	End-of-file or parity error encountered while reading common block CHWT on tape unit 13.
	1070	End-of-file or parity error encountered while reading common block GMBL on tape unit 13.
	1074	End-of-file or parity error encountered while reading common block ECMC on tape unit 13.
	1078	End-of-file or parity error encountered while reading common block ECMD on tape unit 13.
	1082	End-of-file or parity error encountered while reading common block ECME on tape unit 13.
	1090	End-of-file or parity error encountered while reading common block VIS1 on tape unit 13.
	1094	End-of-file or parity error encountered while reading common block VIS2 on tape unit 13.
	1096	End-of-file or parity error encountered while reading common block VIS3 on tape unit 13.
	1098	End-of-file or parity error encountered while reading common block VIS4 on tape unit 13.
	2010	End-of-file or parity error encountered while reading common block KP01 on tape unit 13.
	2020	End-of-file or parity error encountered while reading common block KP02 on tape unit 13.

ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
RDFST (Cont'd)	2030	End-of-file or parity error encountered while reading common block DP04 on tape unit 13.
	2040	End-of-file or parity error encountered while reading common block DP05 on tape unit 13.
	2050	End-of-file or parity error encountered while reading common block QSAC on tape unit 13.
	2060	End-of-file or parity error encountered while reading common block QSAL on tape unit 13.
	2061	End-of-file or parity error encountered while reading common block CLØF on tape unit 13.
	2062	End-of-file or parity error encountered while reading common block NFØF on tape unit 13.
	2063	End-of-file or parity error encountered while reading common block GUNS on tape unit 13.
	2064	End-of-file or parity error encountered while reading common block M28A on tape unit 13.
	2065	End-of-file or parity error encountered while reading common block M28B on tape unit 13.
	2066	End-of-file or parity error encountered while reading common block M28C on tape unit 13.
	2067	End-of-file or parity error encountered while reading common block M28D on tape unit 13.
	2068	End-of-file or parity error encountered while reading common block M28E on tape unit 13.
	2069	End-of-file or parity error encountered while reading common block M28F on tape unit 13.
	2070	End-of-file or parity error encountered while reading common block M28G on tape unit 13.
	2071	End-of-file or parity error encountered while reading common block TV06 on tape unit 13.
	2072	End-of-file or parity error encountered while reading common block FADS on tape unit 13.
	2073	End-of-file or parity error encountered while reading common block DP06 on tape unit 13.
	2074	End-of-file or parity error encountered while reading common block SAS on tape unit 13.
	2075	End-of-file or parity error encountered while reading common block KP07 on tape unit 13.

ERROR MESSAGE LIST

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
RDFST (Cont'd)	2076	End-of-file or parity error encountered while reading common block SY04 on tape unit 13.
	2077	End-of-file or parity error encountered while reading common block M28R on tape unit 13.
	2078	End-of-file or parity error encountered while reading common block GUNI on tape unit 13.
		- CORRECTIVE ACTION -
		All of the above listed errors are concerned with reading situation data from the FRAG3 history event file. Each one can be caused by an unexpected end of file or an unrecoverable parity error. In either case, this data file must be dumped (at the appropriate location) to determine the exact cause of error. End-of-file conditions may have been caused by erroneous ends of the FRAG3 run. In this case, it will be necessary to rerun the FRAG3. Parity errors can usually be corrected by standard system "clean-up" techniques (such as cleaning the tape and read heads). If these fail, it may be necessary to rerun the FRAG3.
SORTEV	1100	Parity error encountered while reading input control Card Type 1.
	1500	Parity error encountered while reading input control Card Type 2.
		- CORRECTIVE ACTION -
		Parity errors can be corrected by either rerunning the job or, if this fails, using standard system "clean-up" techniques.
	9010	Unexpected end of file encountered while reading input control Card Type 2.
		- CORRECTIVE ACTION -
		The number of Type 2 cards input did not agree with the number input for variable NU on the Type 1 card.
	9020	End-of-file or parity error encountered while reading situation data on tape unit 13.
		- CORRECTIVE ACTION -
		The same corrective actions noted for subroutine RDFST are applicable here.

ERROR FROM SUBROUTINE	AT STATEMENT NUMBER	EXPLANATION
SØRTEV (Cont'd)	9090	Error encountered during execution of SØRSEV. - CORRECTIVE ACTION- An error in either SØRSEV or the system utility SORT/MERGE occurred. A core dump of the affected area will be necessary to determine the exact cause.

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